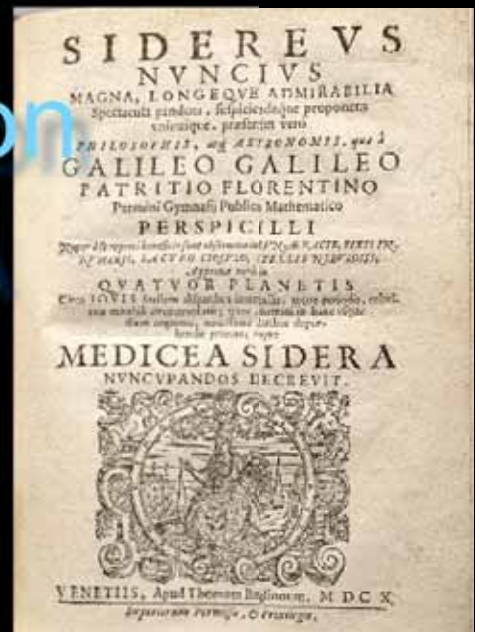
Exploration and Science in the Outer Solar System

Torrence V. Johnson
Jet Propulsion Laboratory, Caltech

1st Space Exploration Conference, AIAA

1 February 2005
Walt Disney World, Florida


SIDEREVS
NVNCIVS
MAGNA, LONGEQVE ADMIRABILIA
GALILEO GALILEO
PATRITIO FLORENTINO
PERSPICILLI
QVATVOR PLANETIS
MEDICEA SIDERA
NVNCVPANDOS DECREVIT.
VENETIIS, Apud Thomam Baglionum. M DC X

EXPLORATION

n 1: to travel for the purpose of discovery

SCIENCE

n 1: The observation, identification, description, experimental investigation, and theoretical explanation of phenomena

H.M.S Beagle in the Strait of Magellan

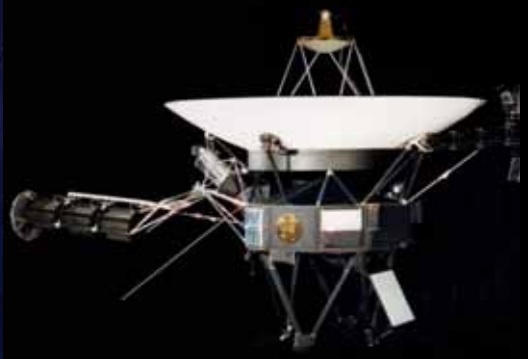
It's Hard to Explore the Outer Solar System ....

because

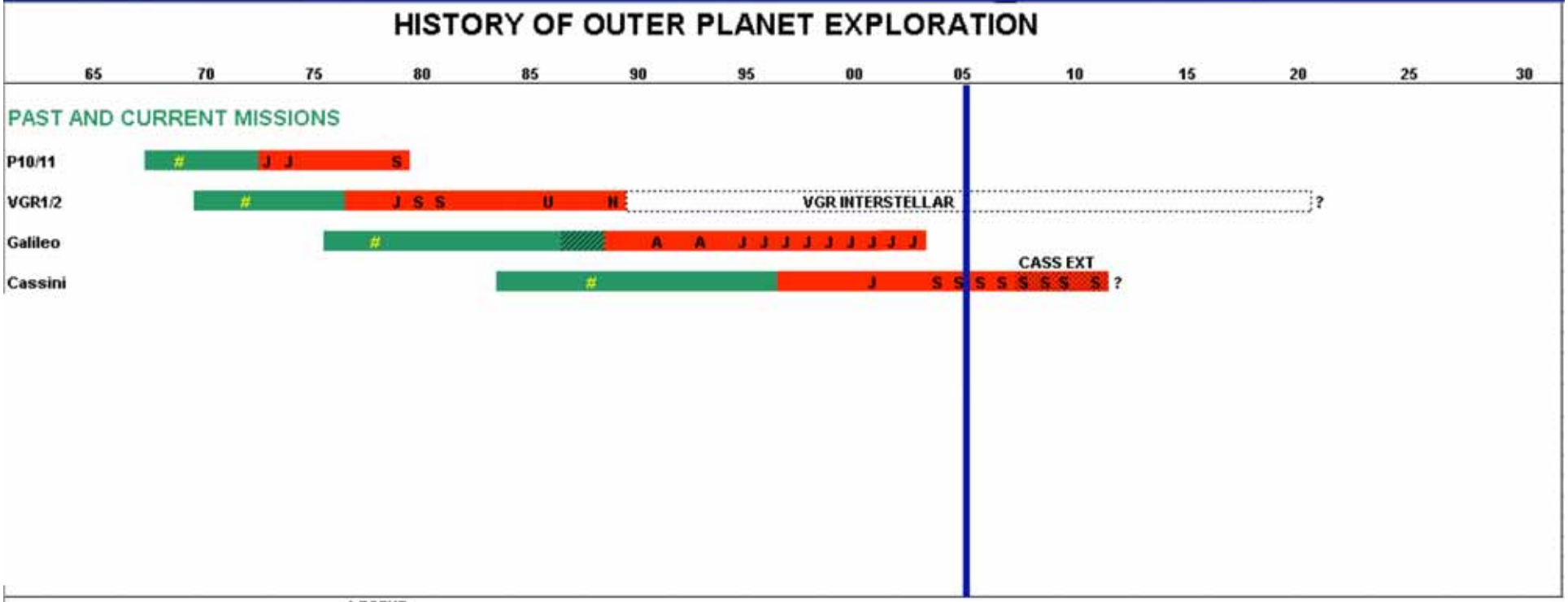
Space is Huge, Man!

Outer Solar System Scale --- In Time

- Jupiter
  - ~ 40 light min
  - Spacecraft: 2.5 – 6 yrs
- Saturn
  - ~ 80 light min
  - Spacecraft: 4 – 7 yrs
- Pluto
  - >5 light HOURS
  - Spacecraft: > ~ 10 yrs



HISTORY OF OUTER PLANET EXPLORATION



LEGEND

SCI. REC.

NEW START

TARGET(S)

X Y

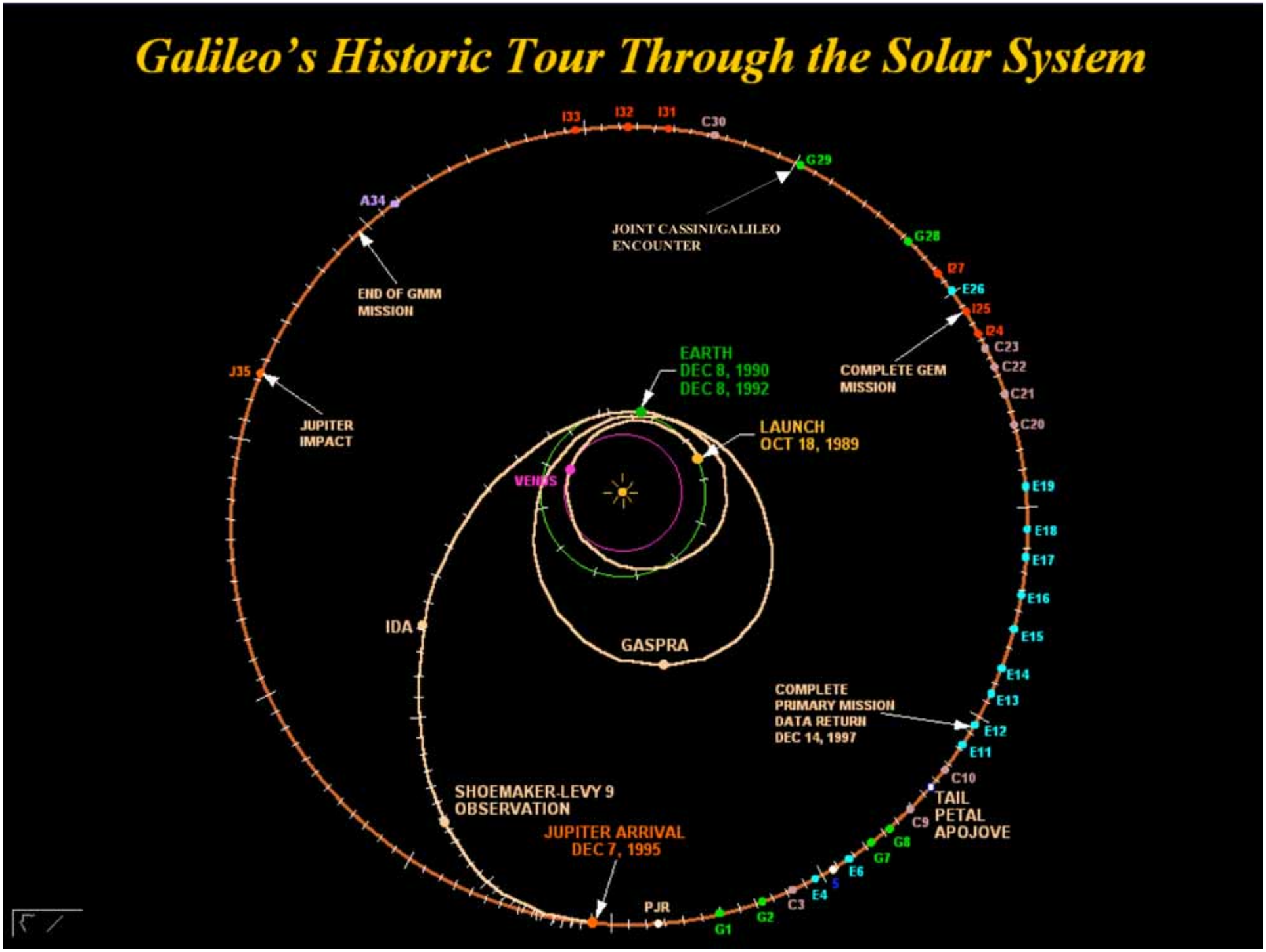
PLANNING & DEVELOPMENT

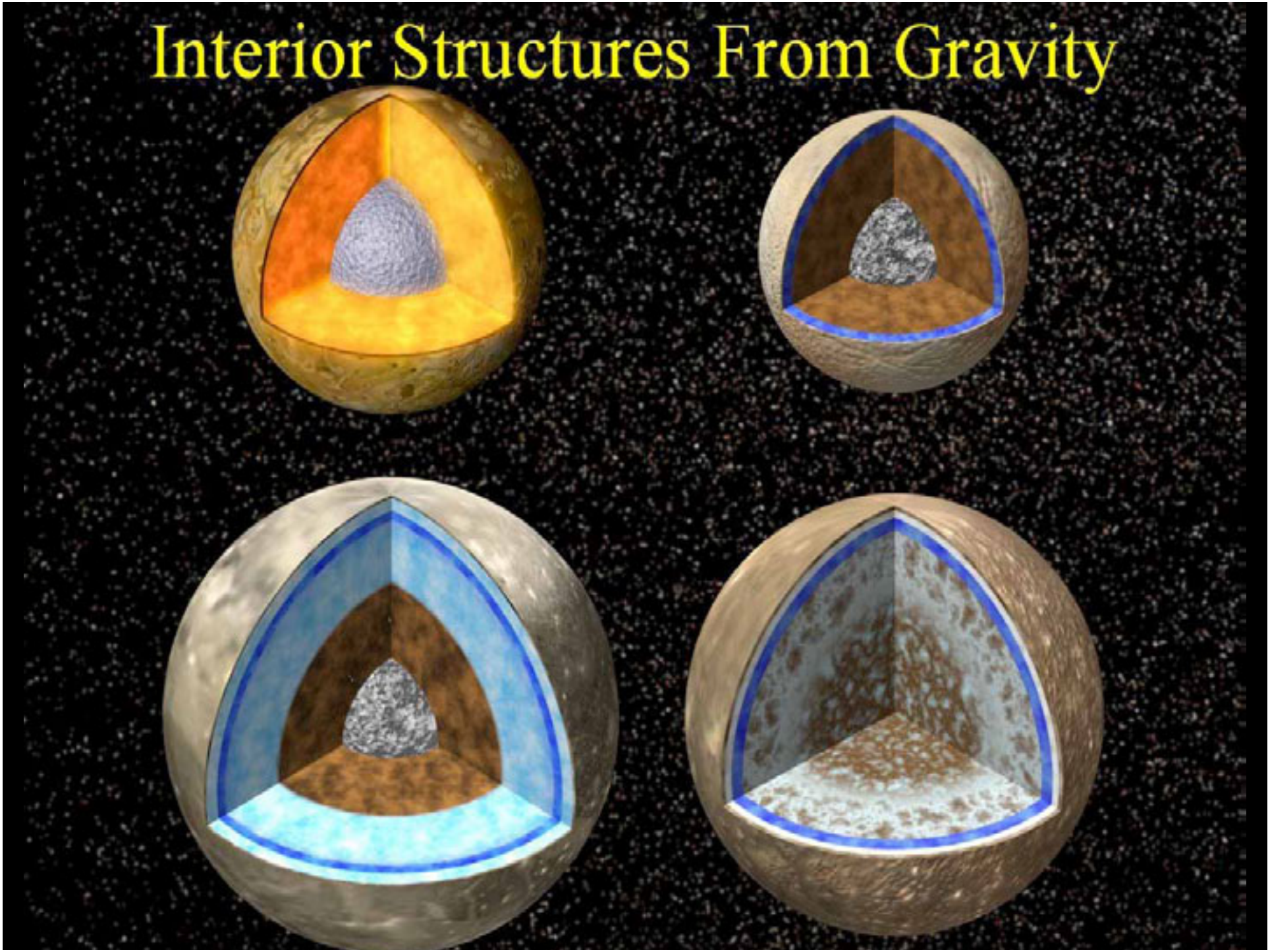
OPERATIONS

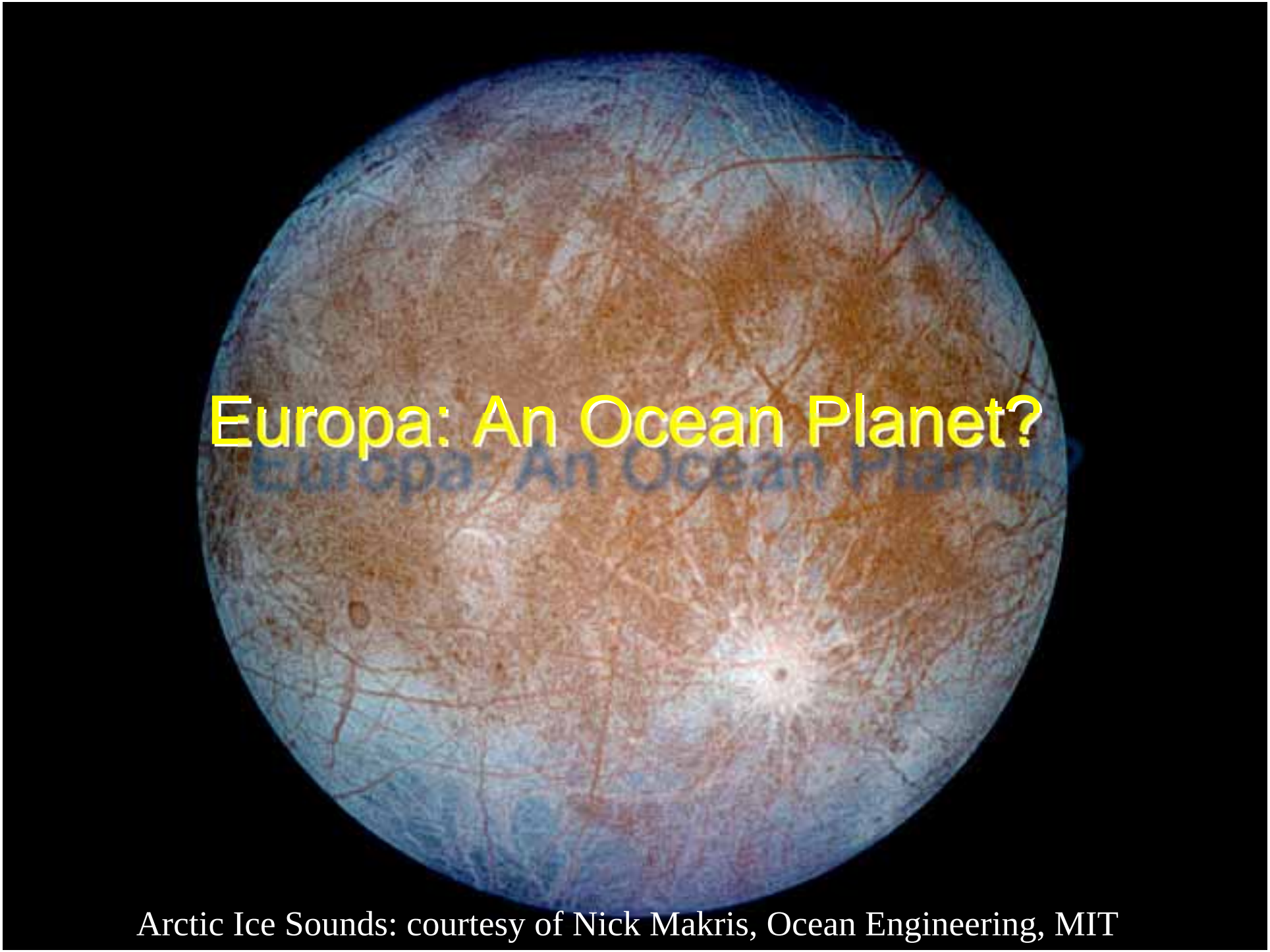
T. V. Johnson, December 2004

Comments on Outer Planet Exploration

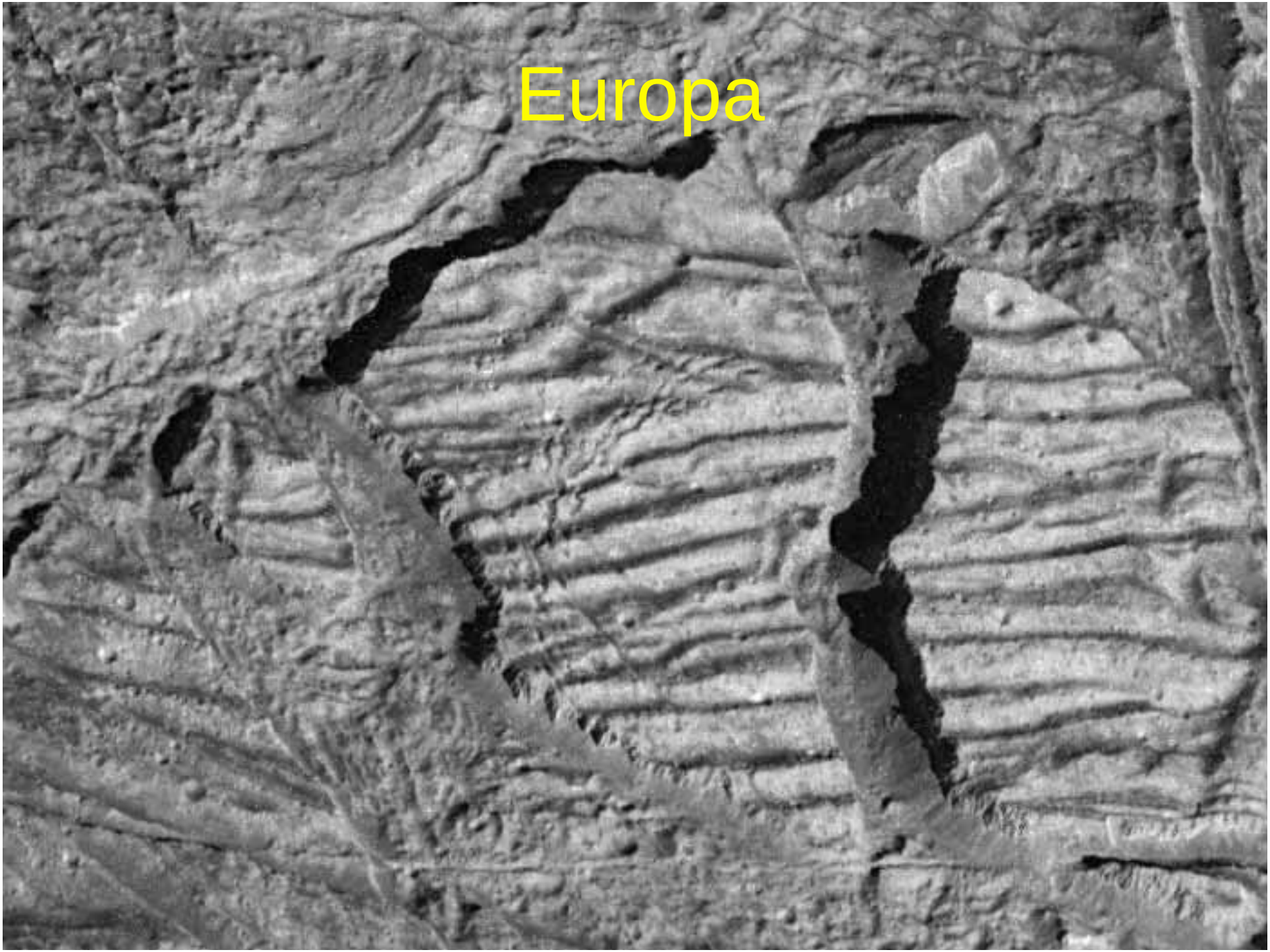
Galileo's Historic Tour Through the Solar System

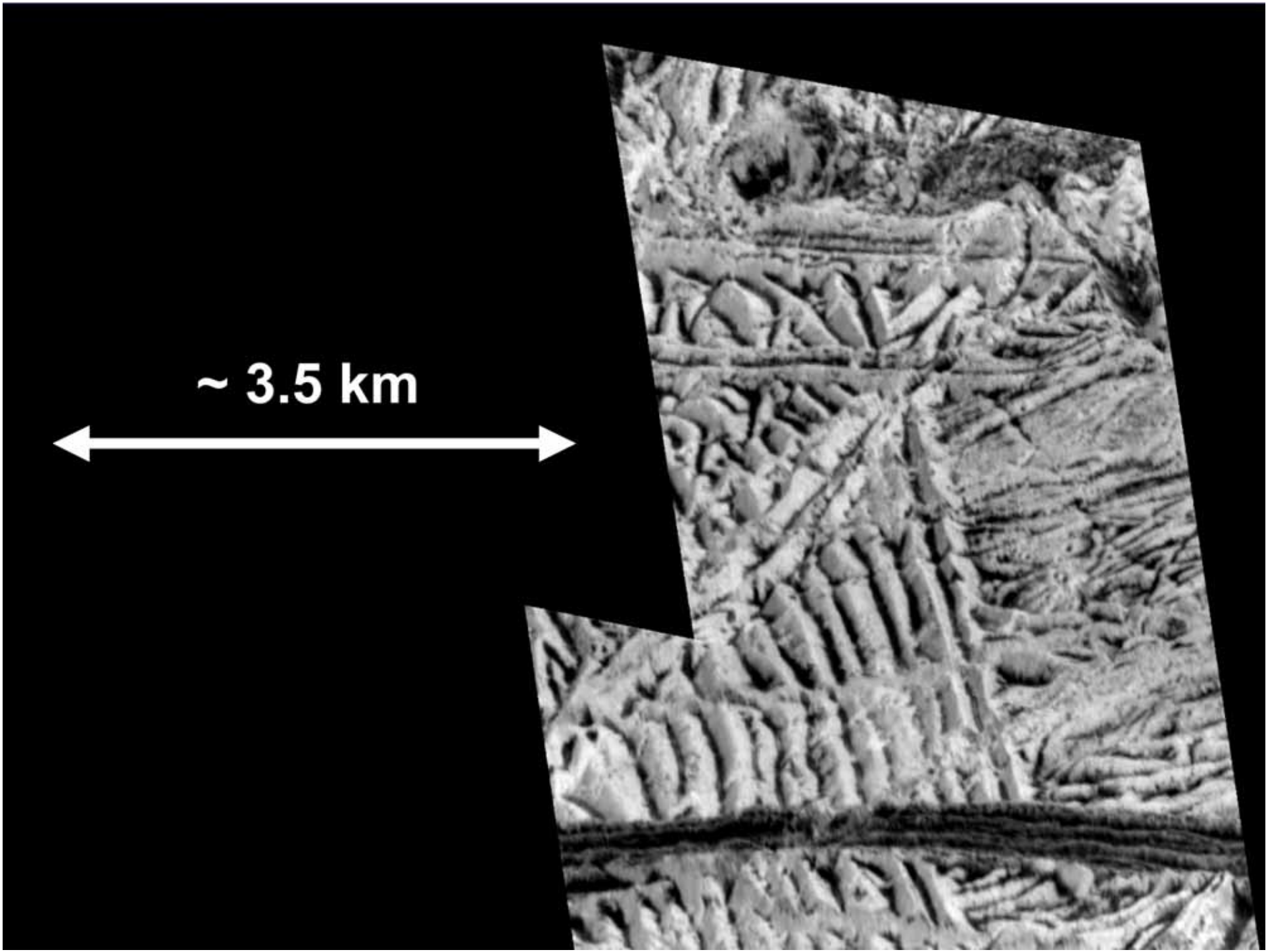


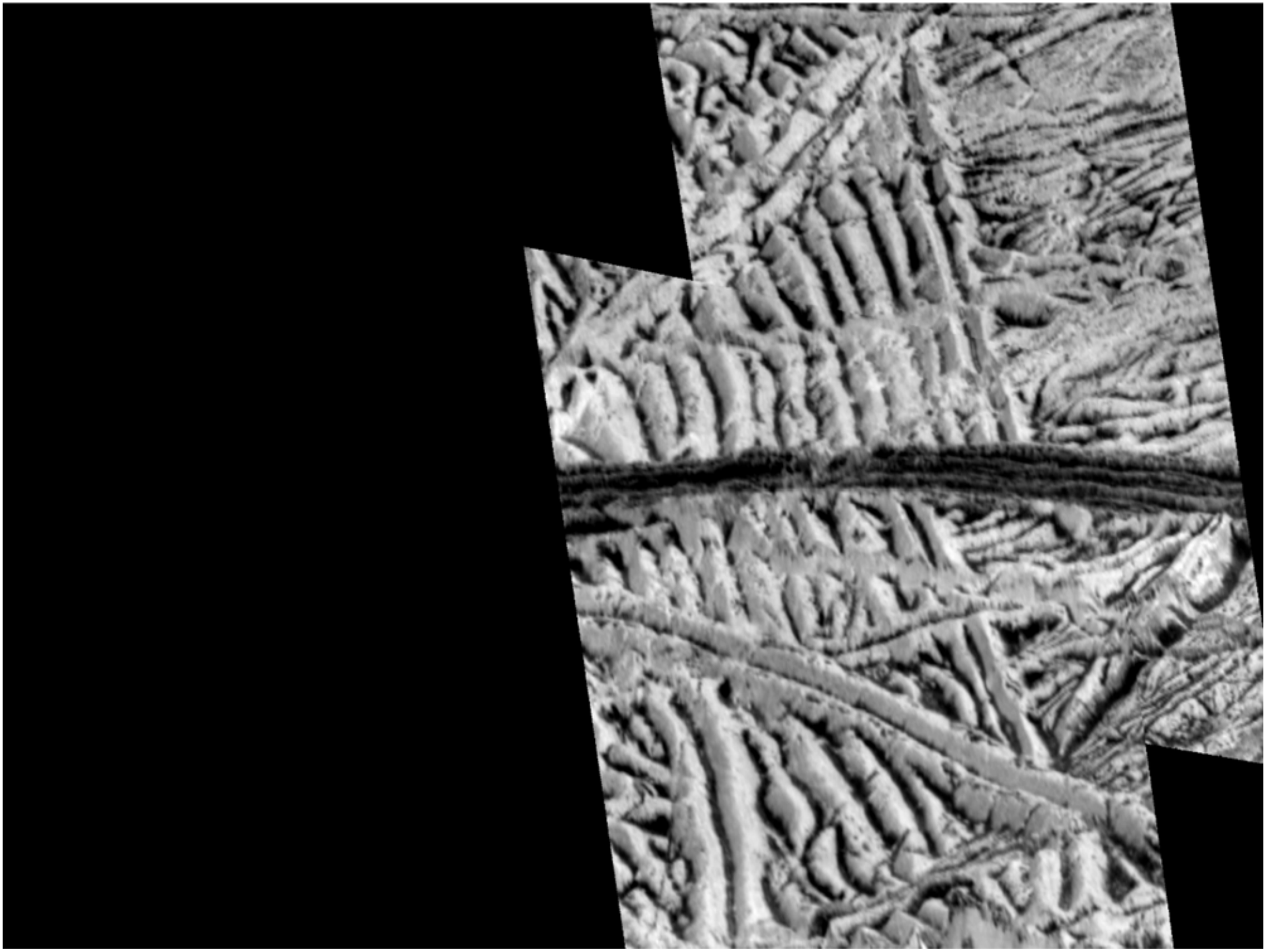

Interior Structures From Gravity

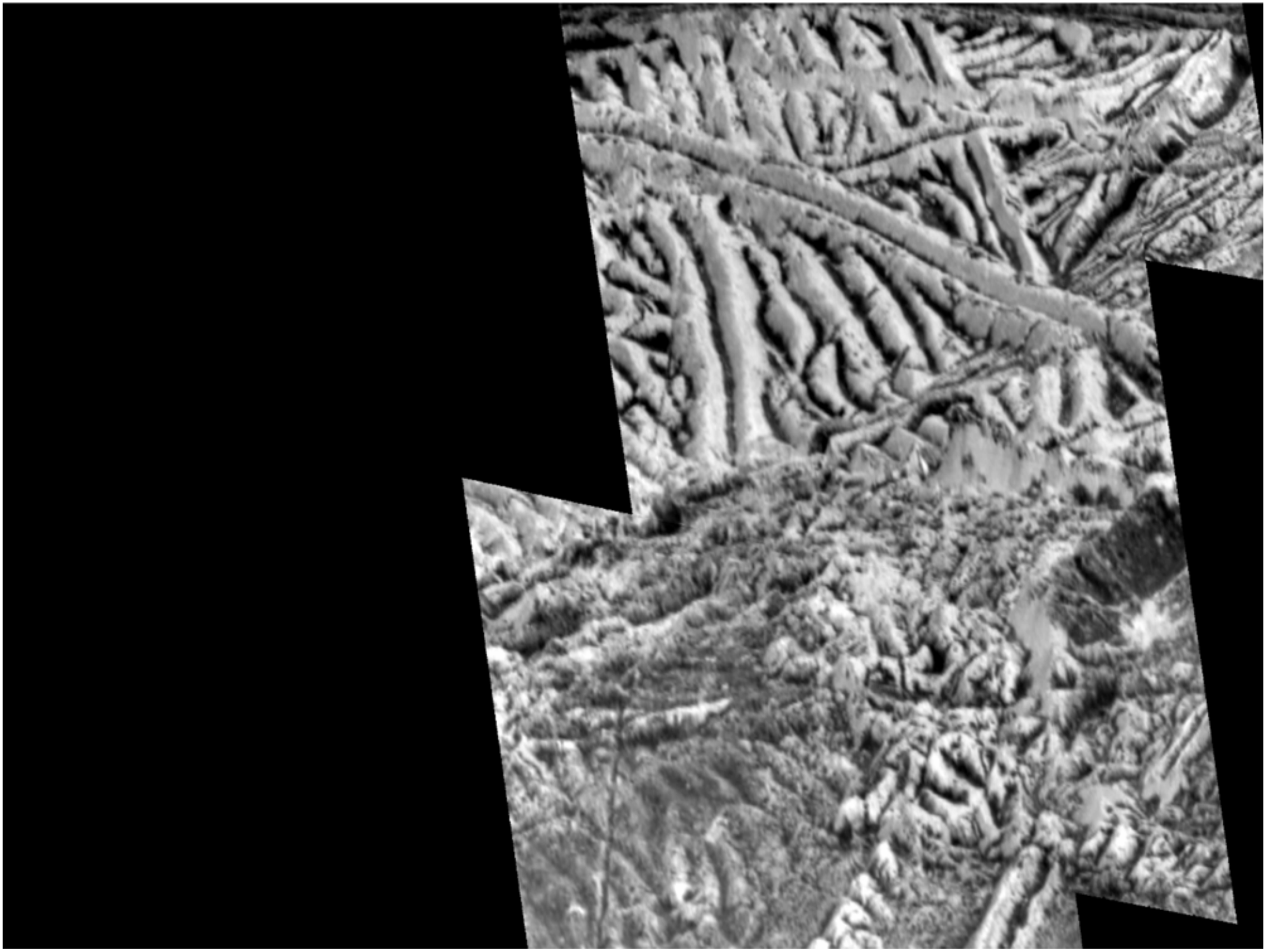


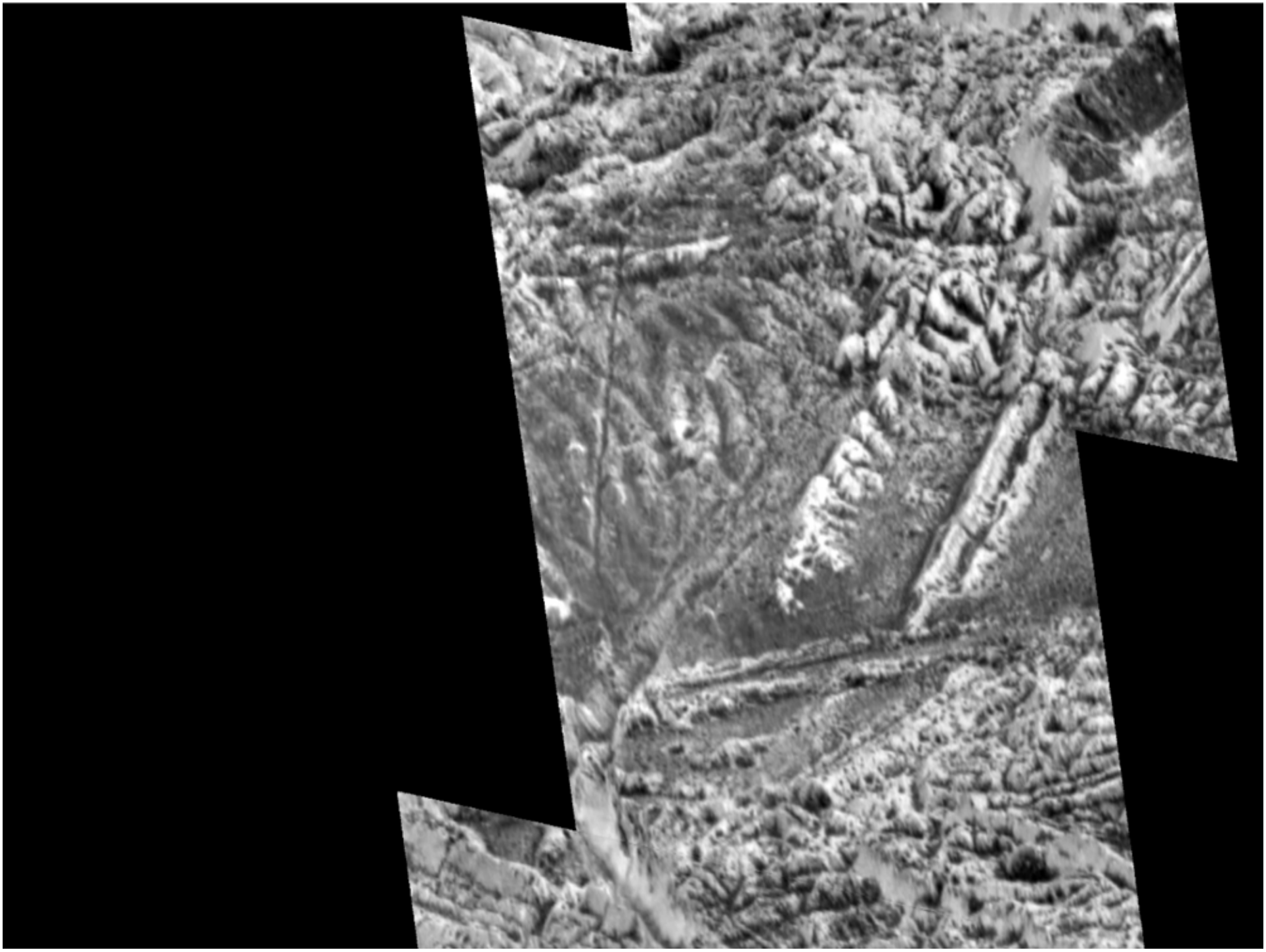
Arctic Ice Sounds: courtesy of Nick Makris, Ocean Engineering, MIT

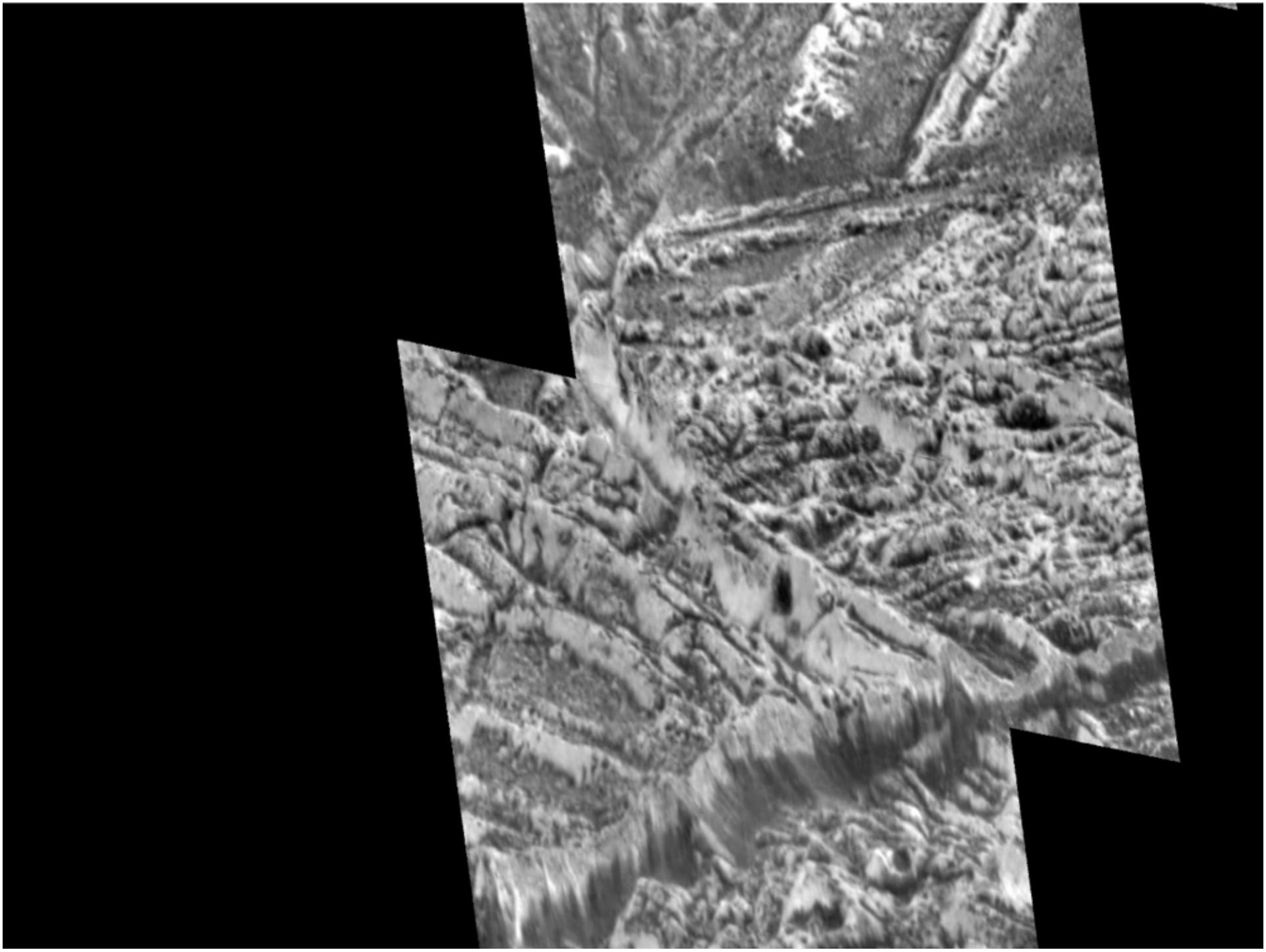

Europa

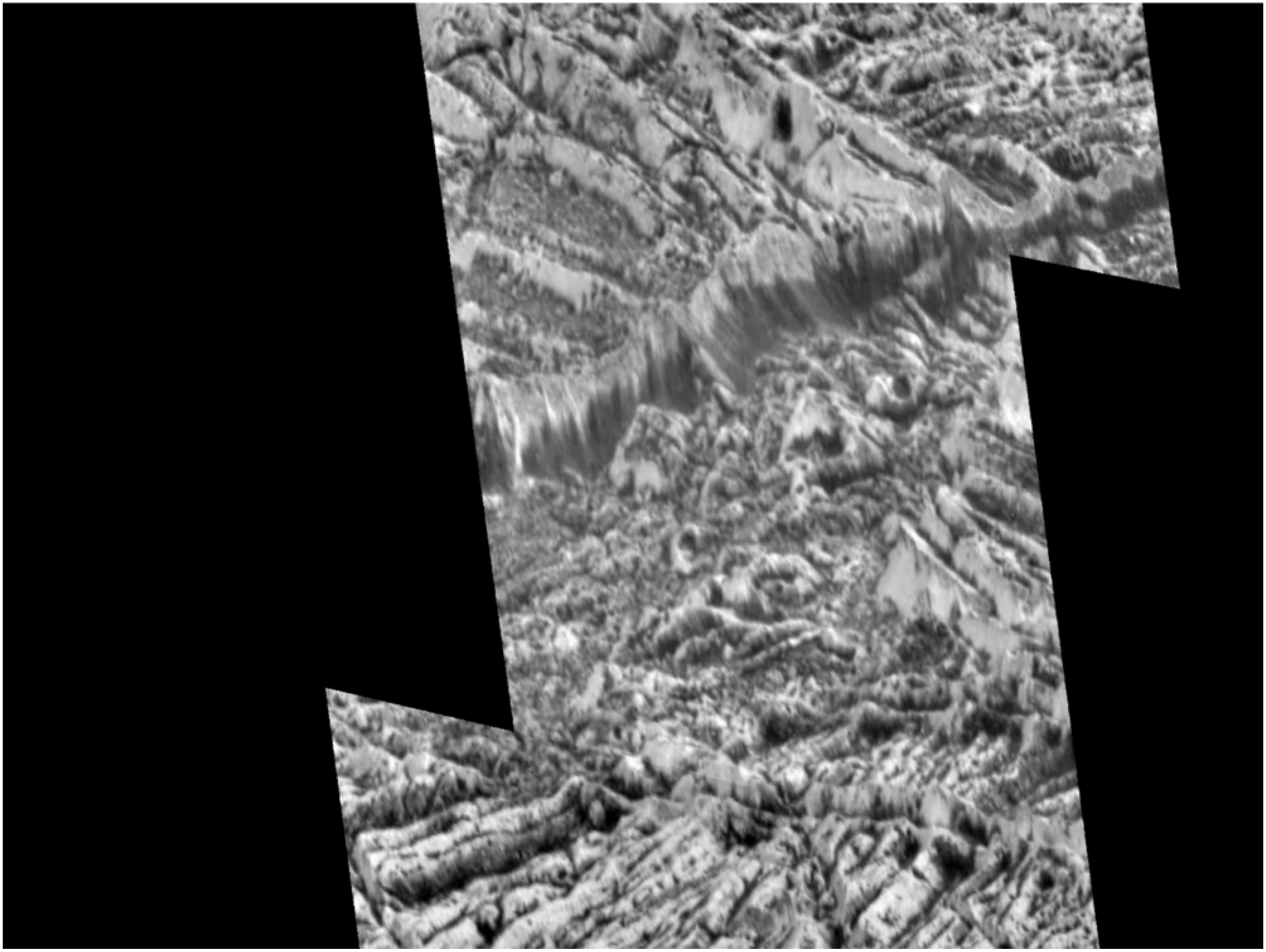

~ 3.5 km

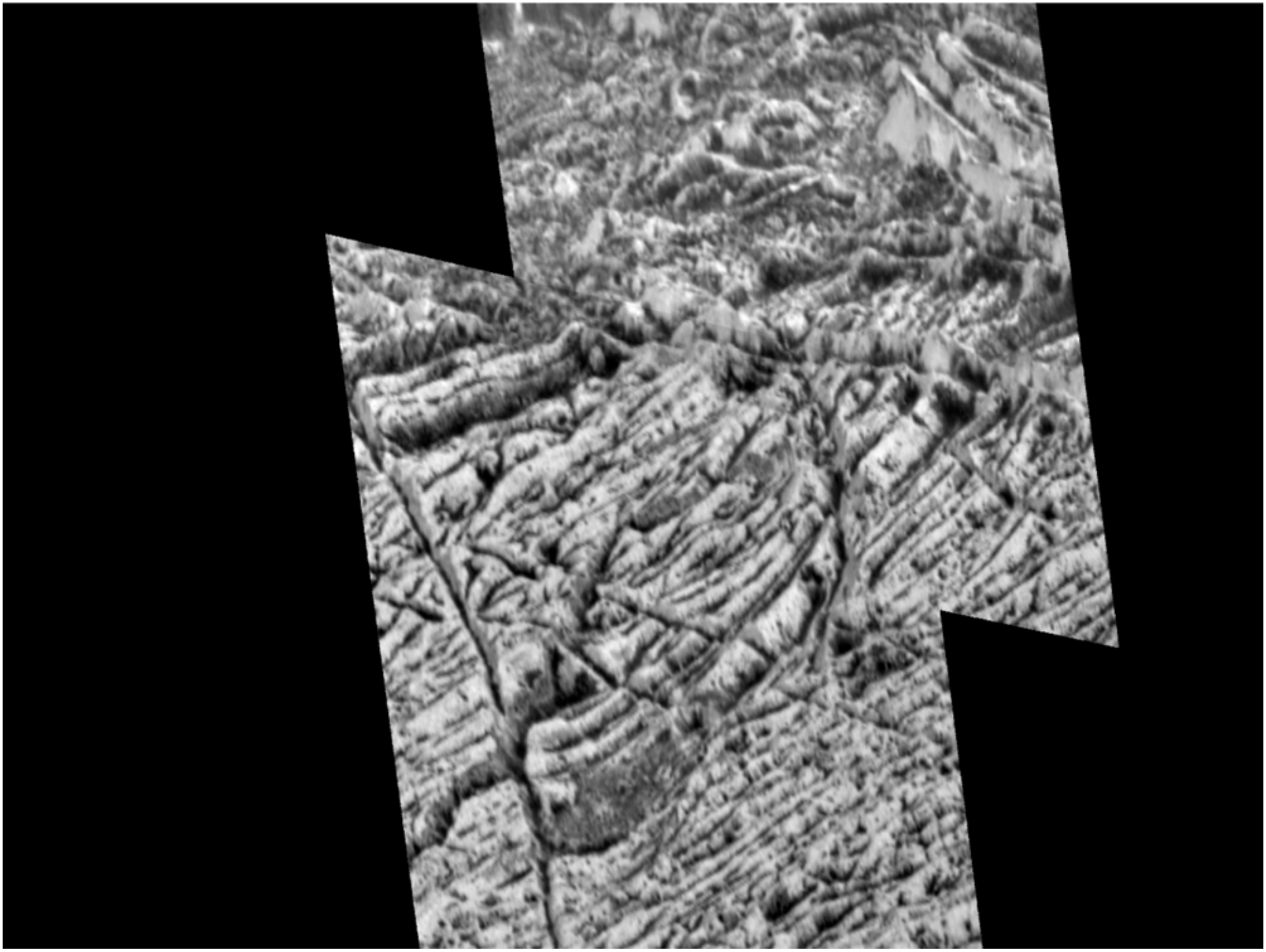


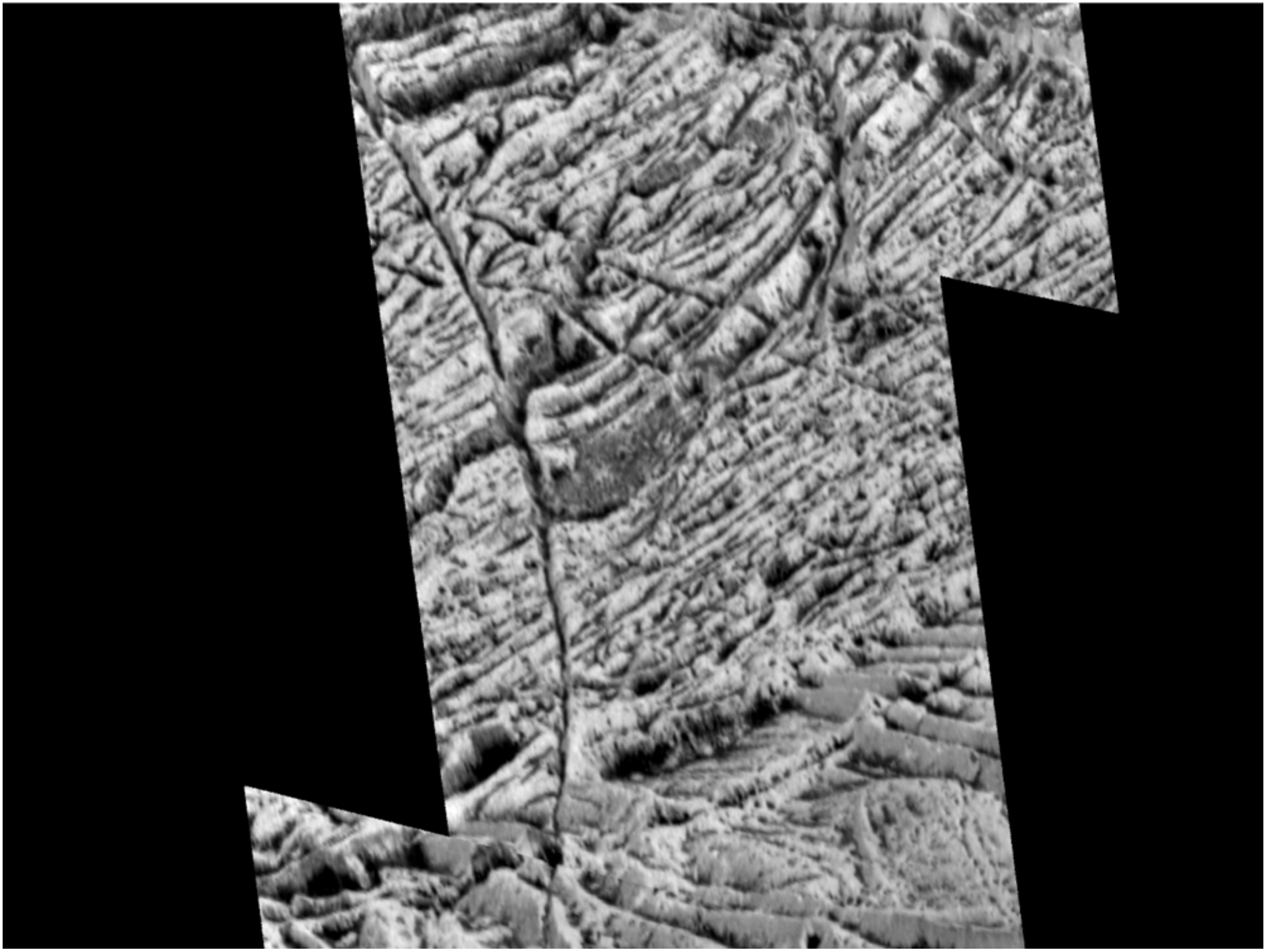


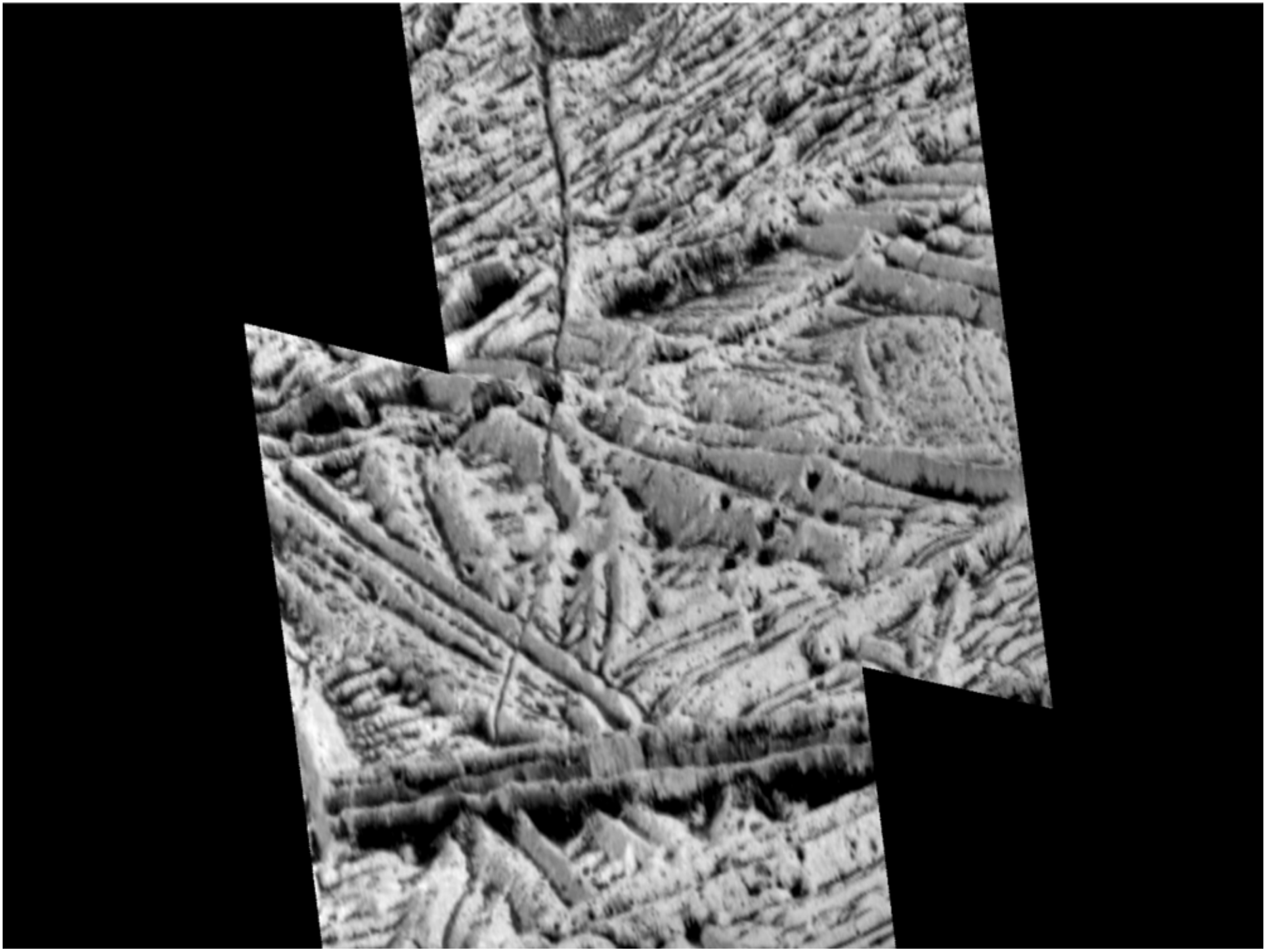


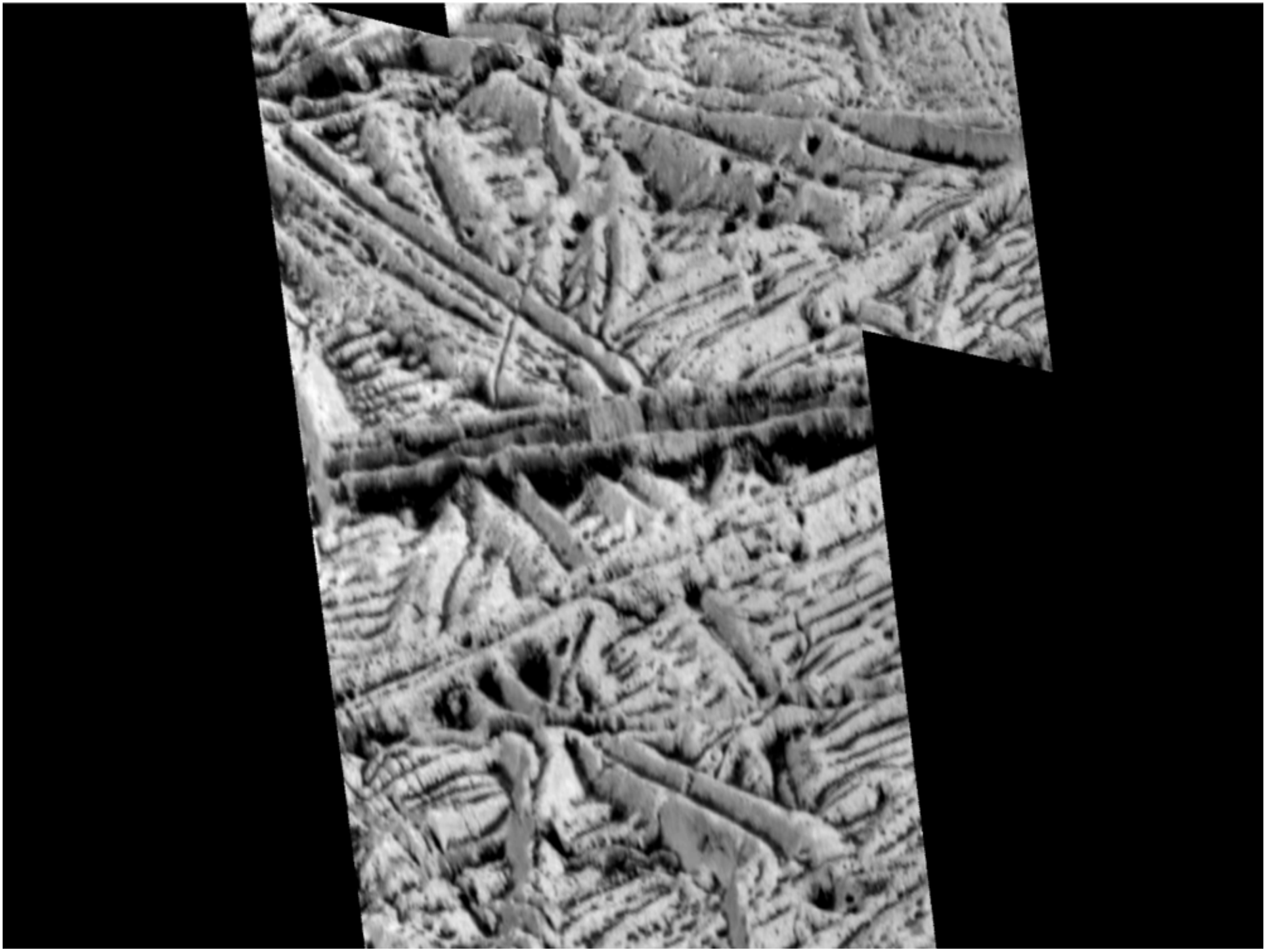


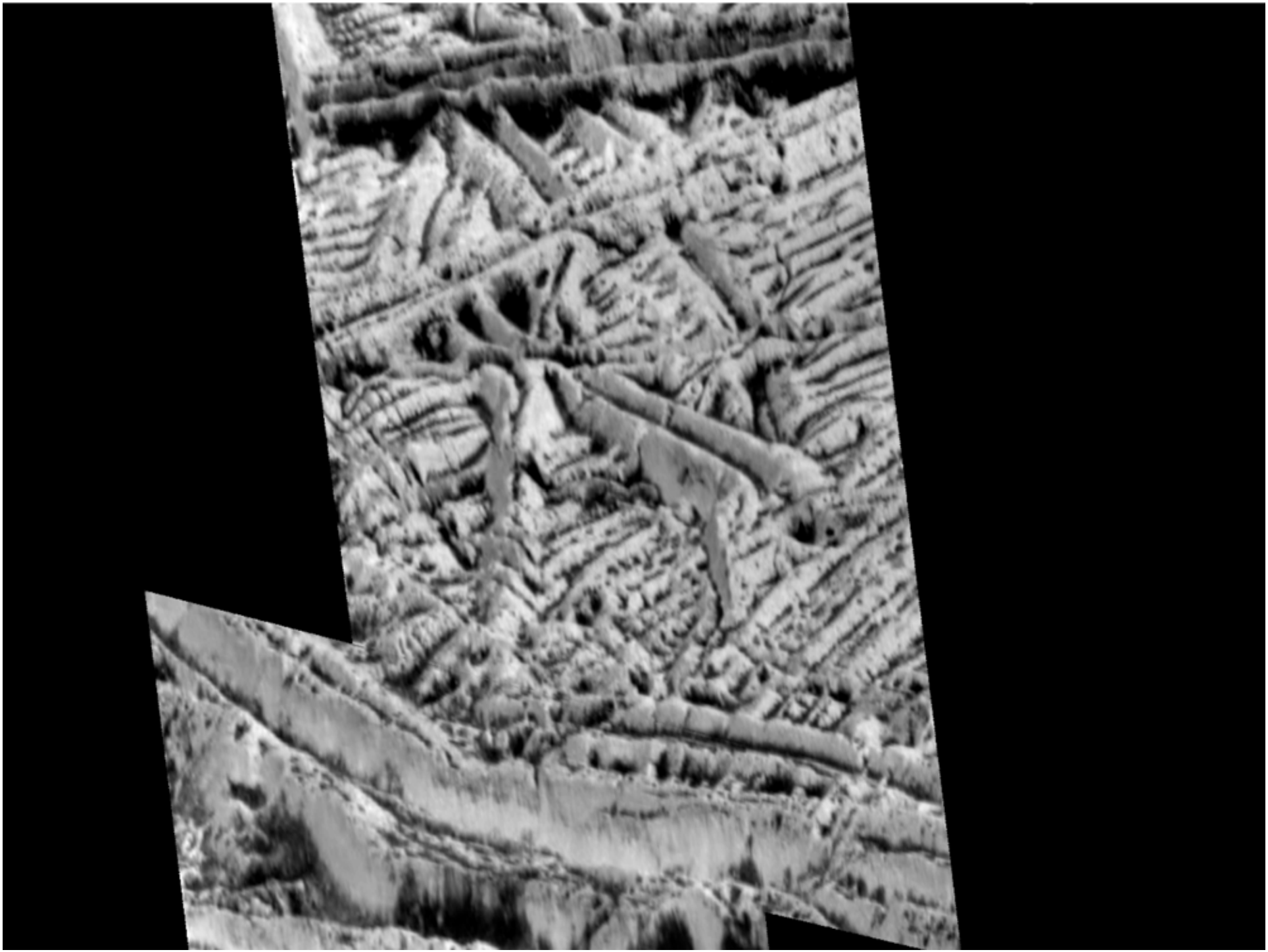


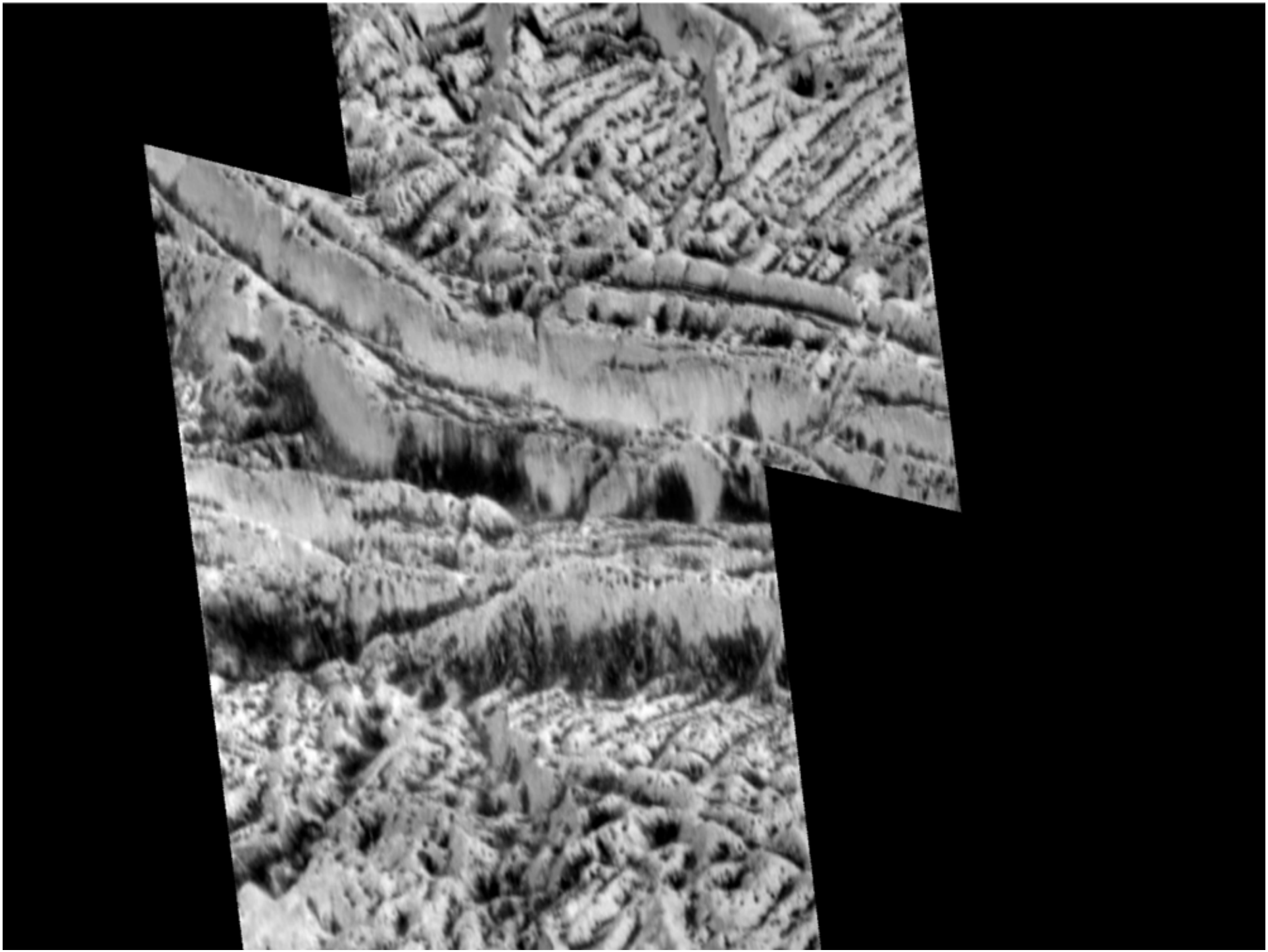


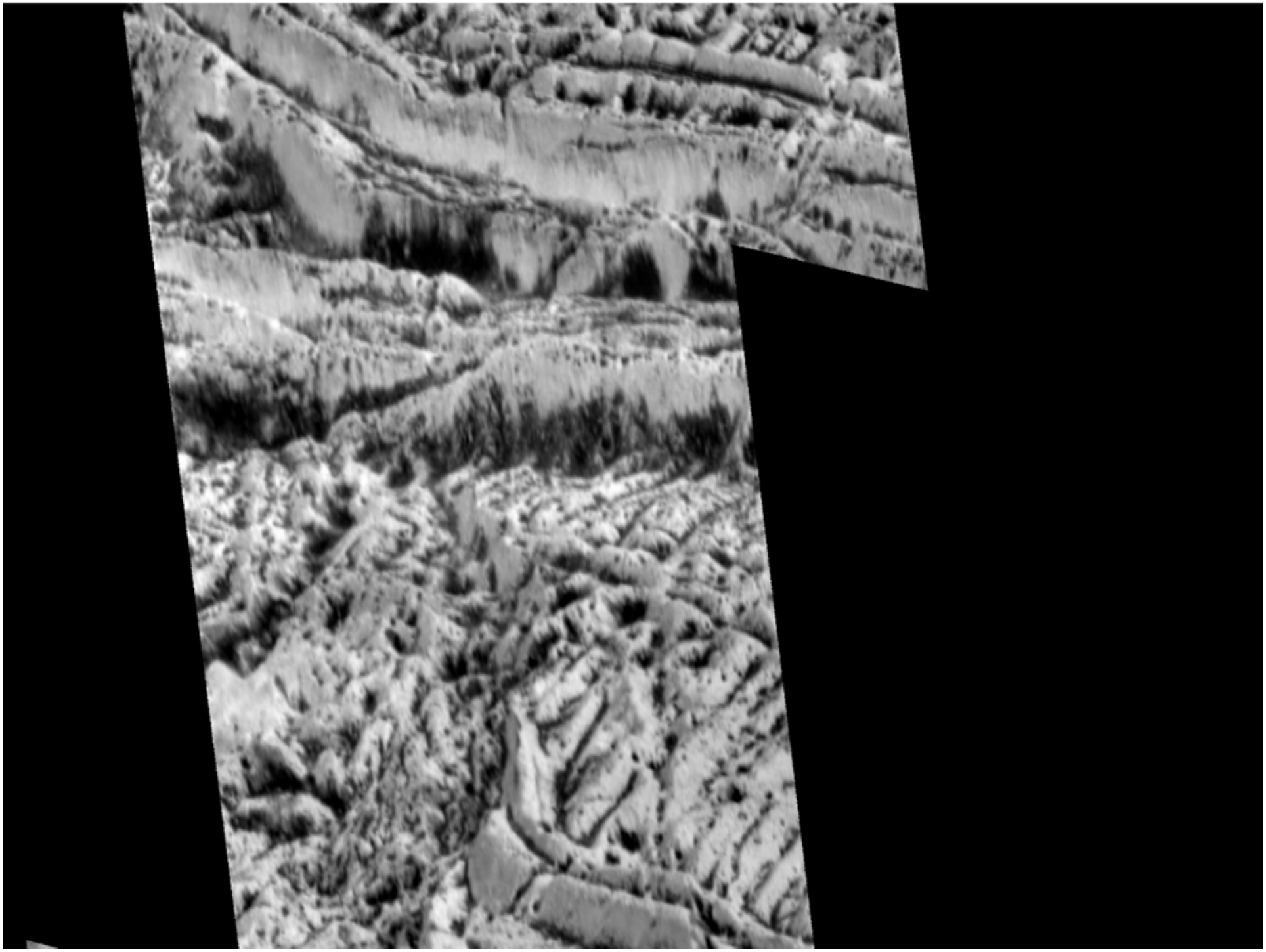


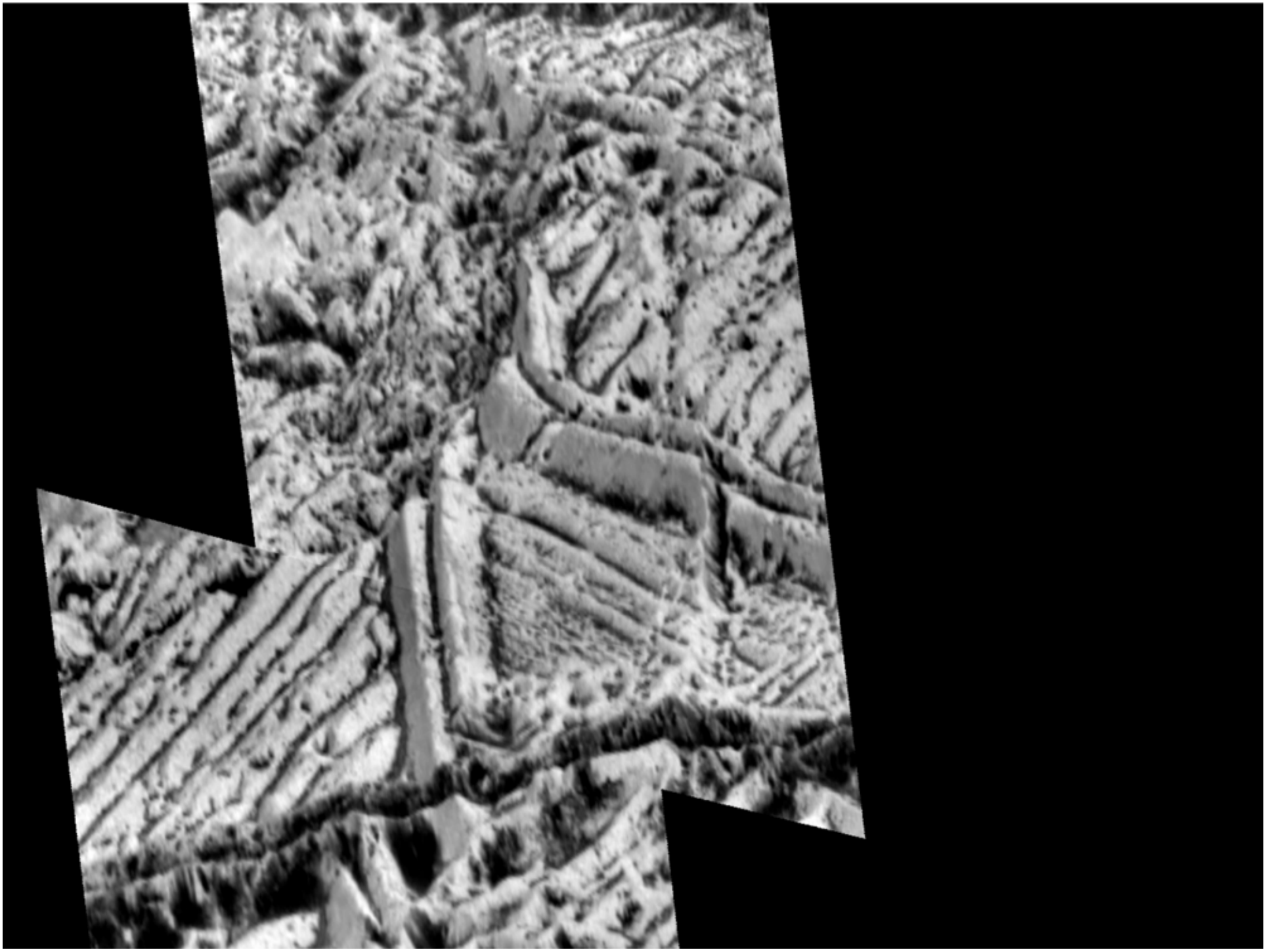


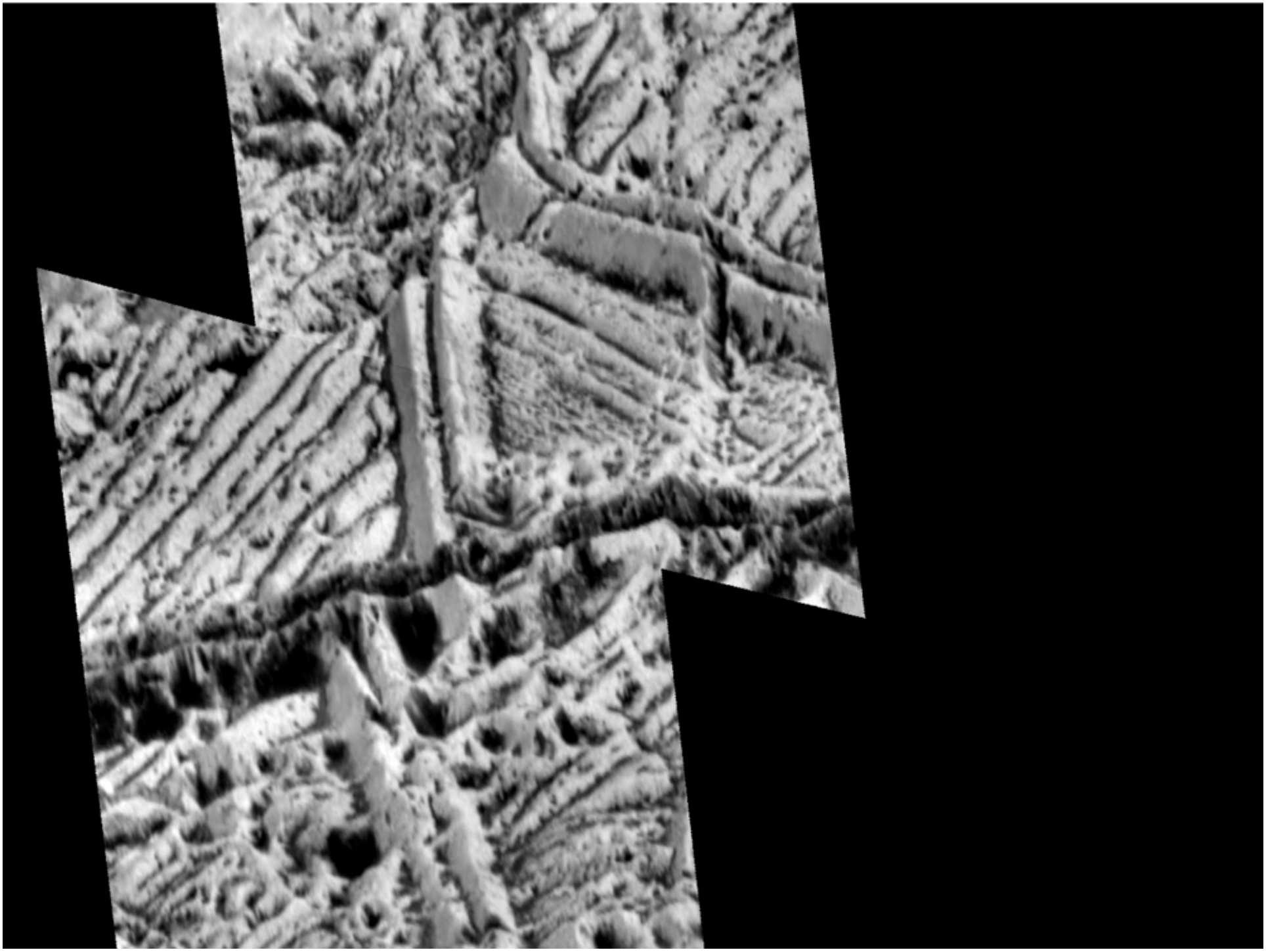


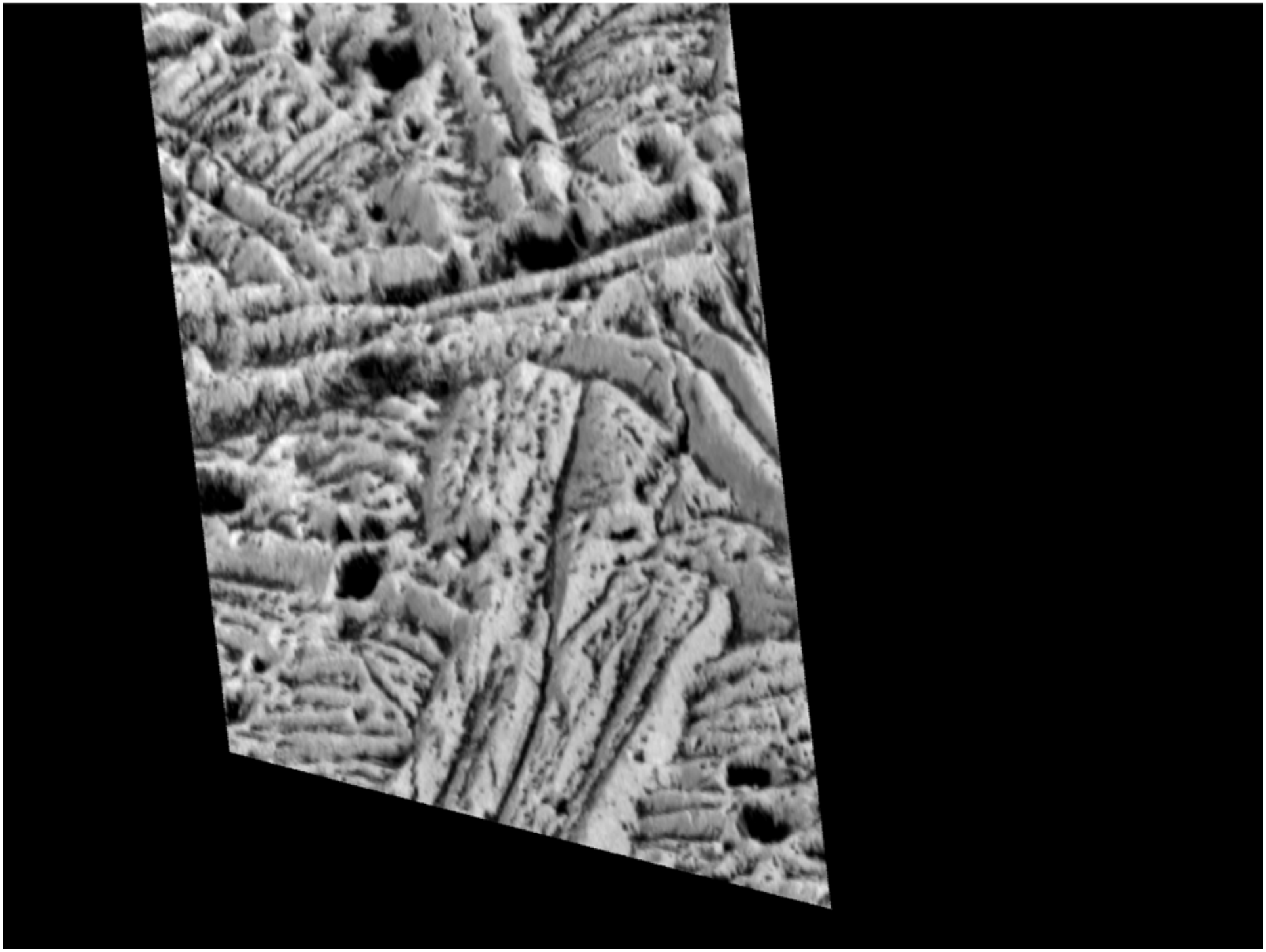


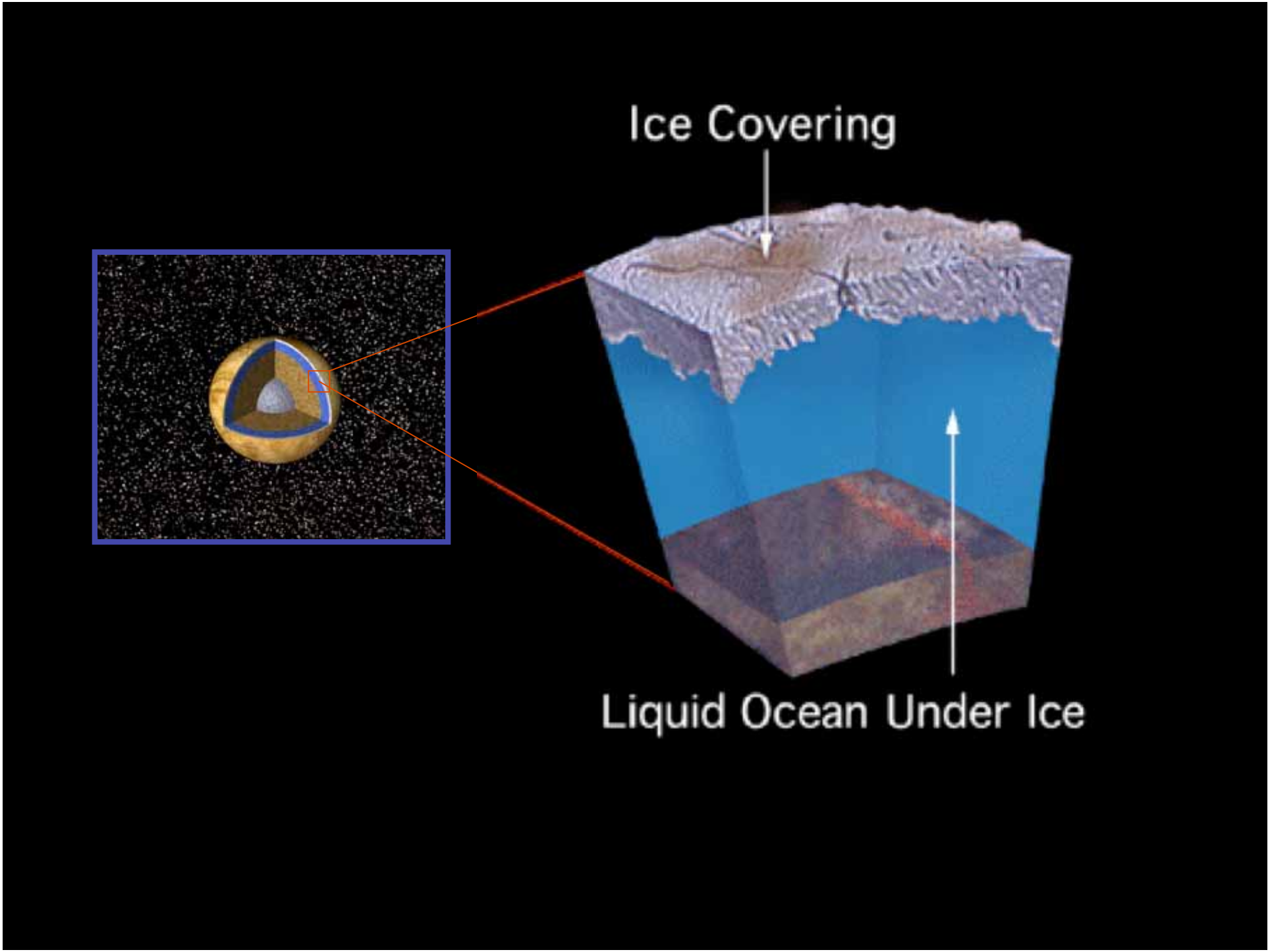


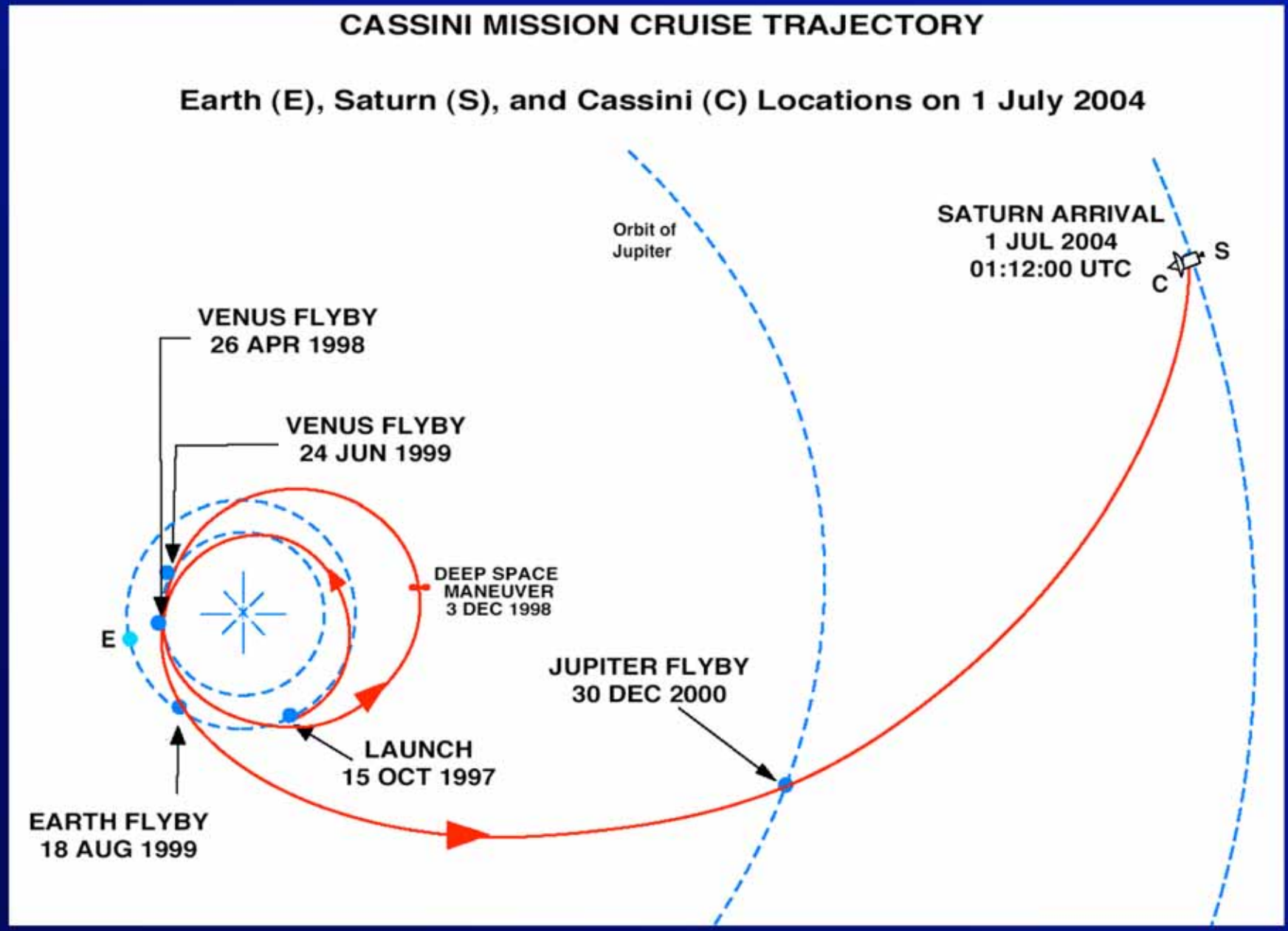




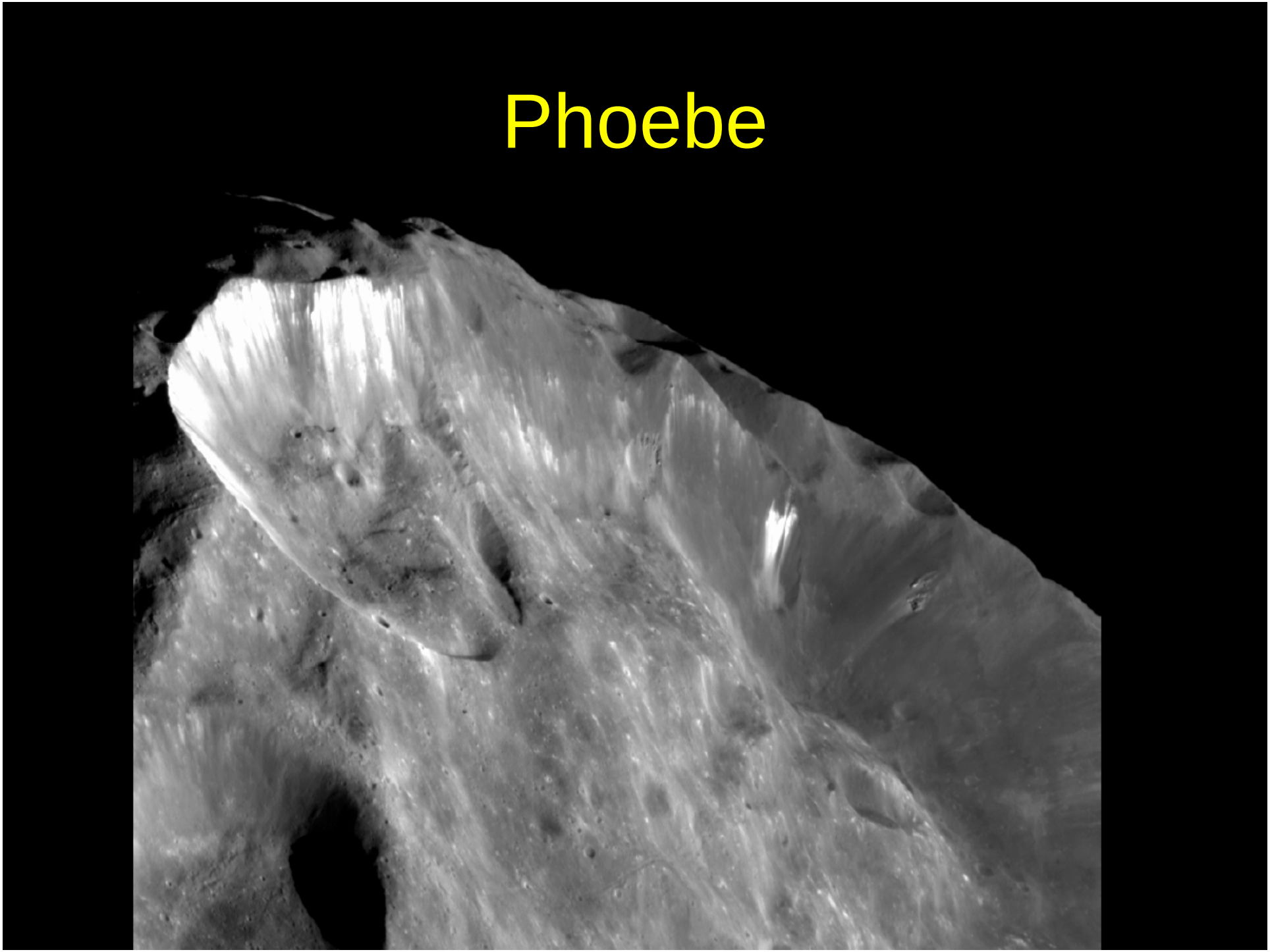


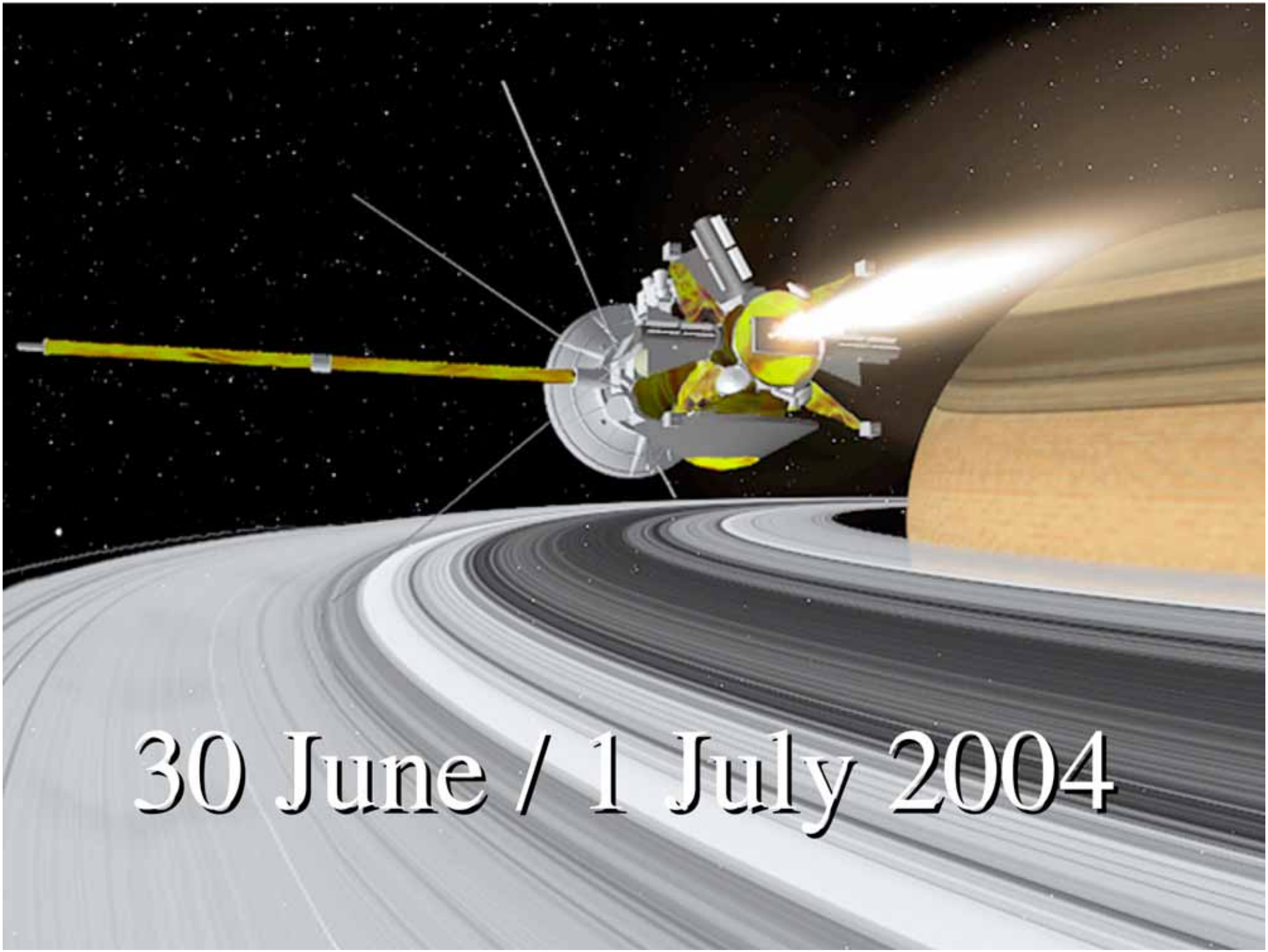


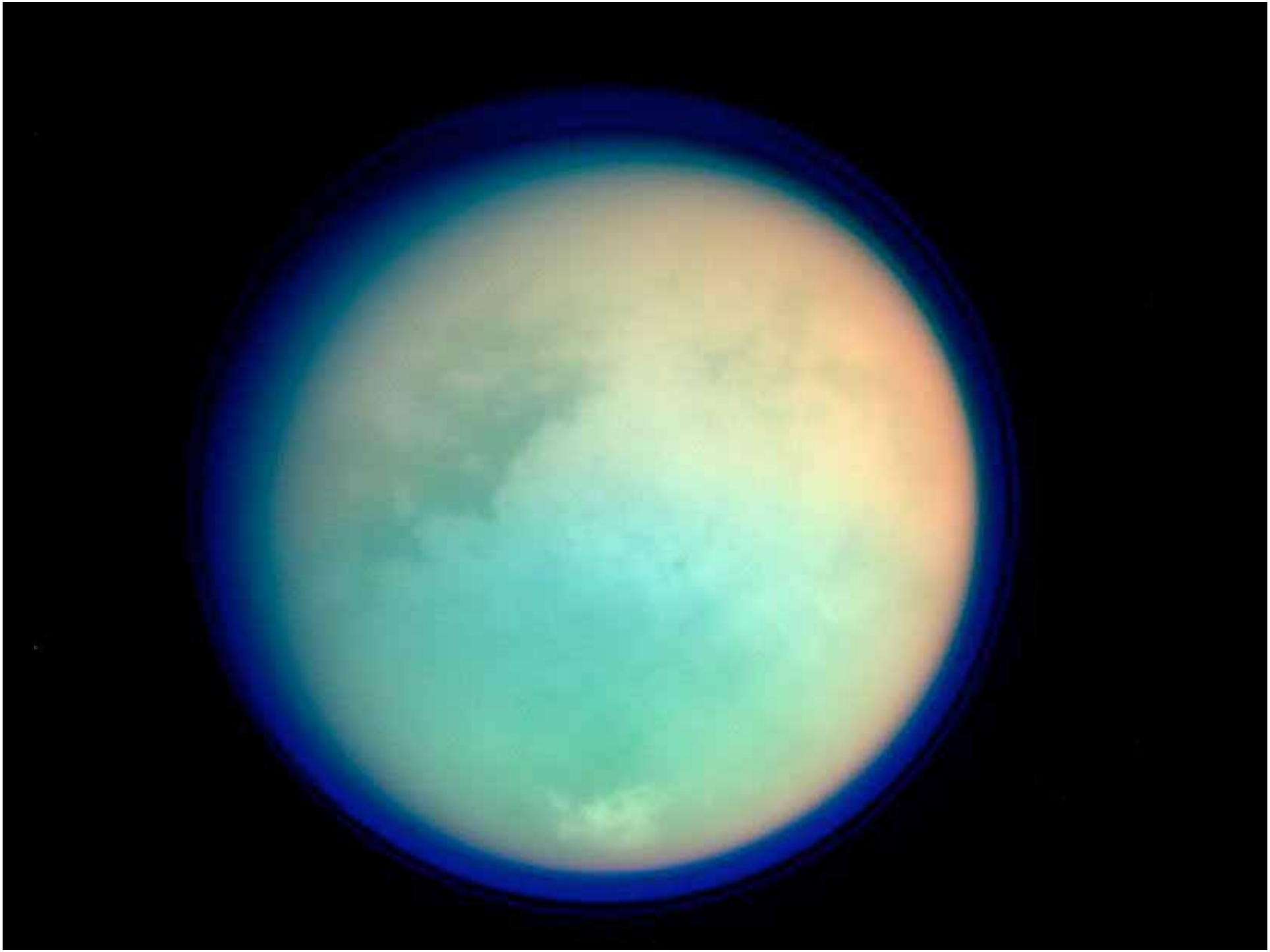

Ice Covering
Liquid Ocean Under Ice

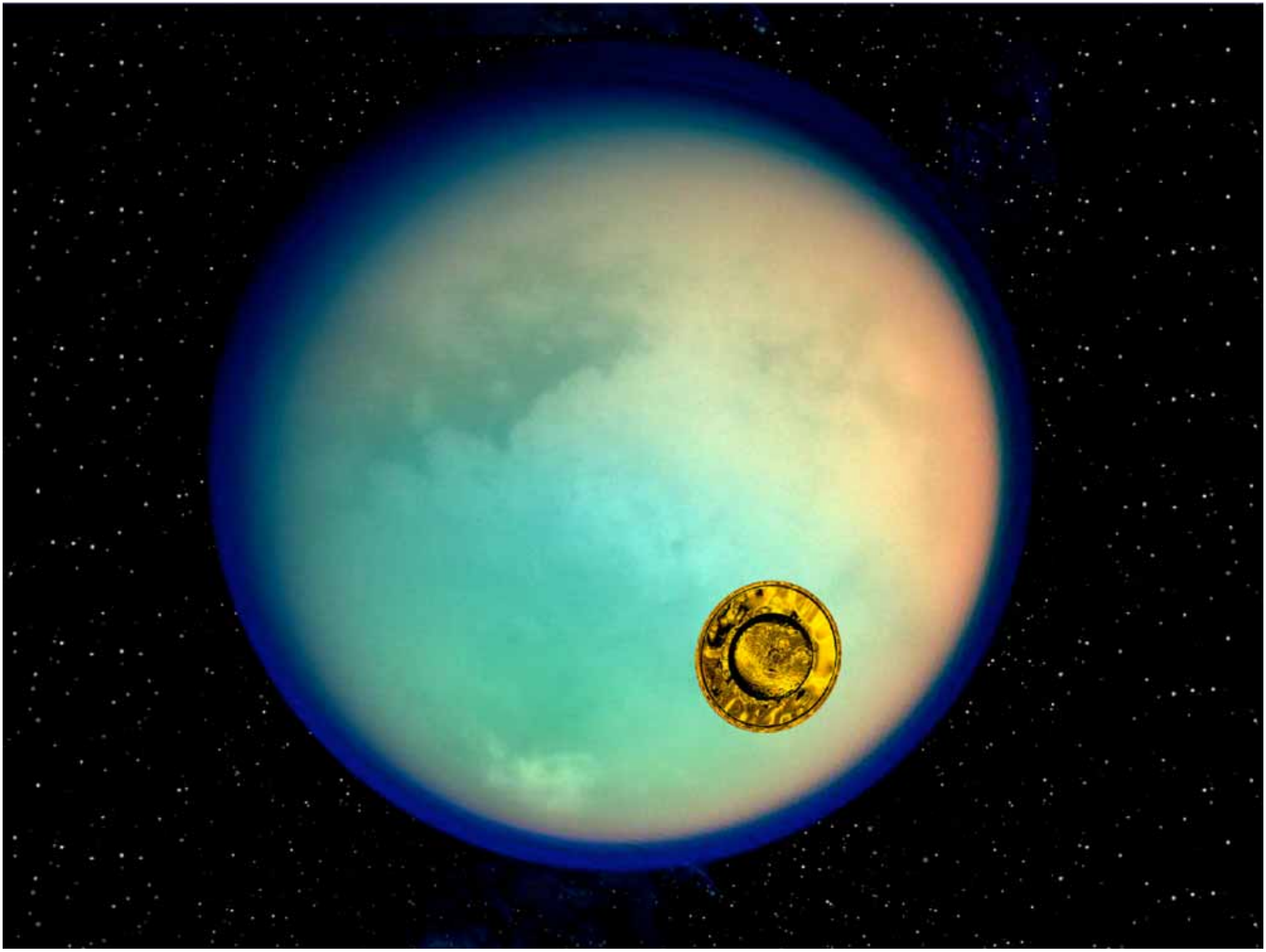

CASSINI MISSION CRUISE TRAJECTORY
Earth (E), Saturn (S), and Cassini (C) Locations on 1 July 2004
Orbit of Jupiter
SATURN ARRIVAL
1 JUL 2004
01:12:00 UTC
S
C
VENUS FLYBY
26 APR 1998
VENUS FLYBY
24 JUN 1999
DEEP SPACE MANEUVER
3 DEC 1998
E
JUPITER FLYBY
30 DEC 2000
LAUNCH
15 OCT 1997
EARTH FLYBY
18 AUG 1999

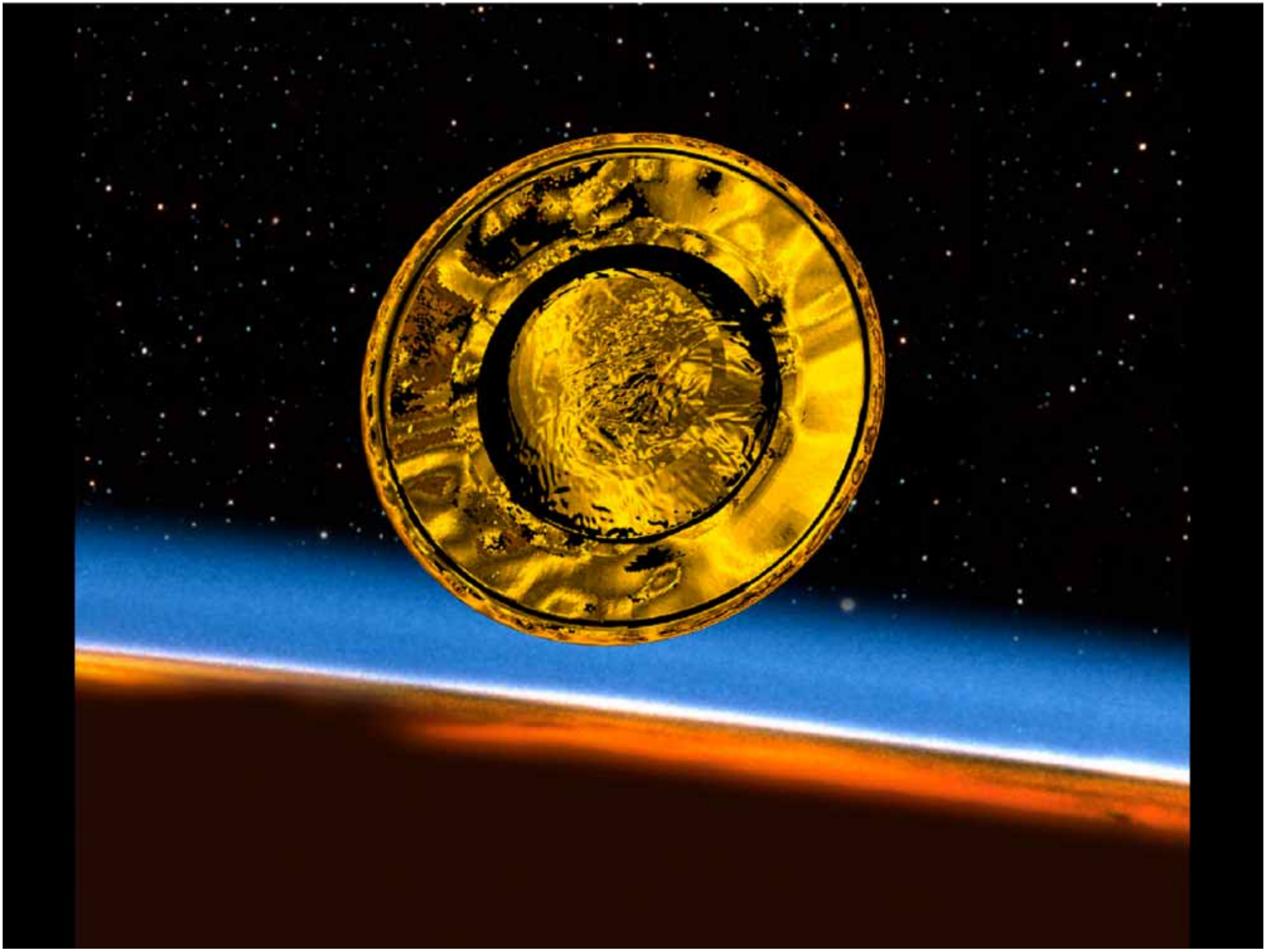
Phoebe

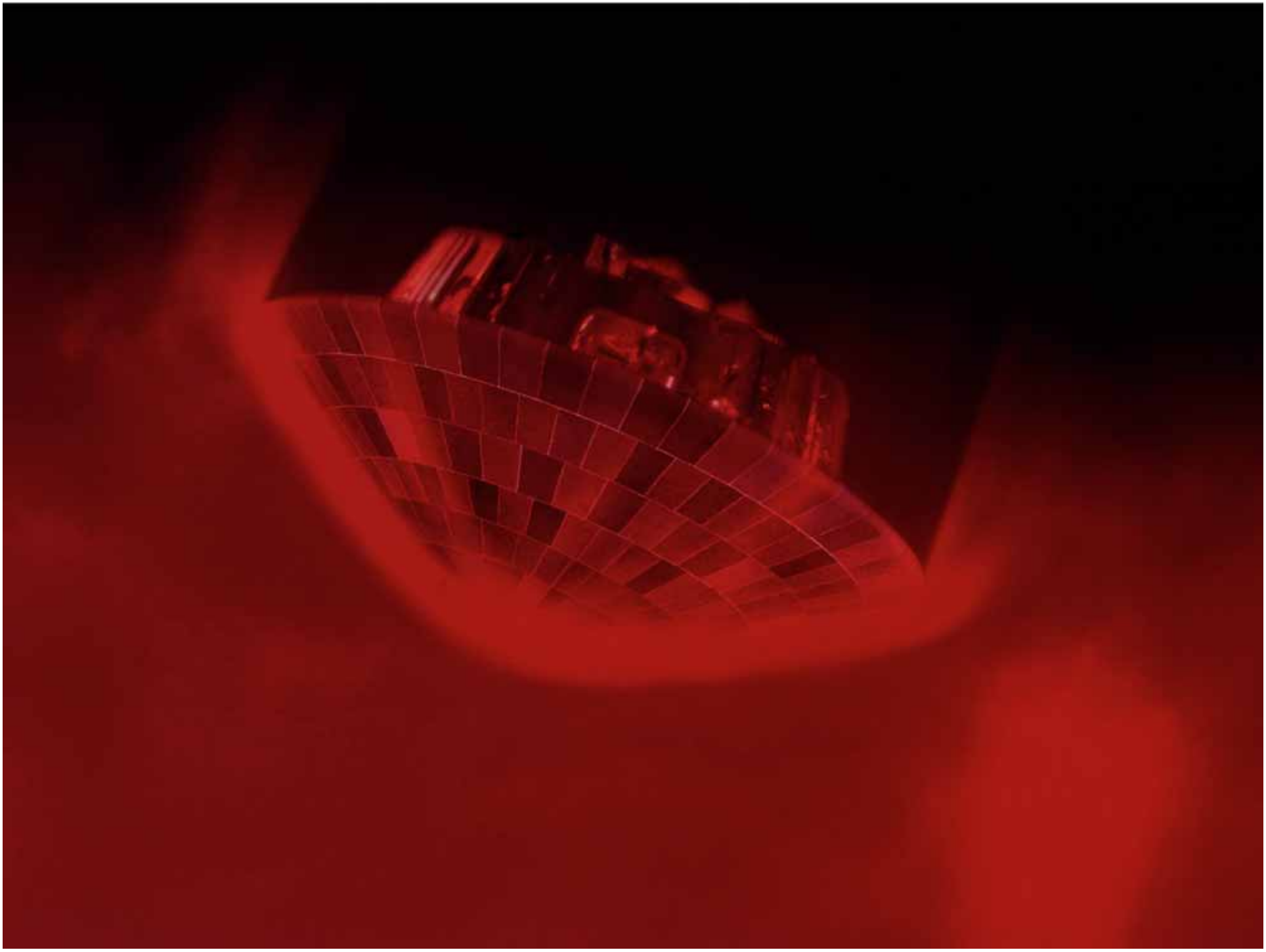


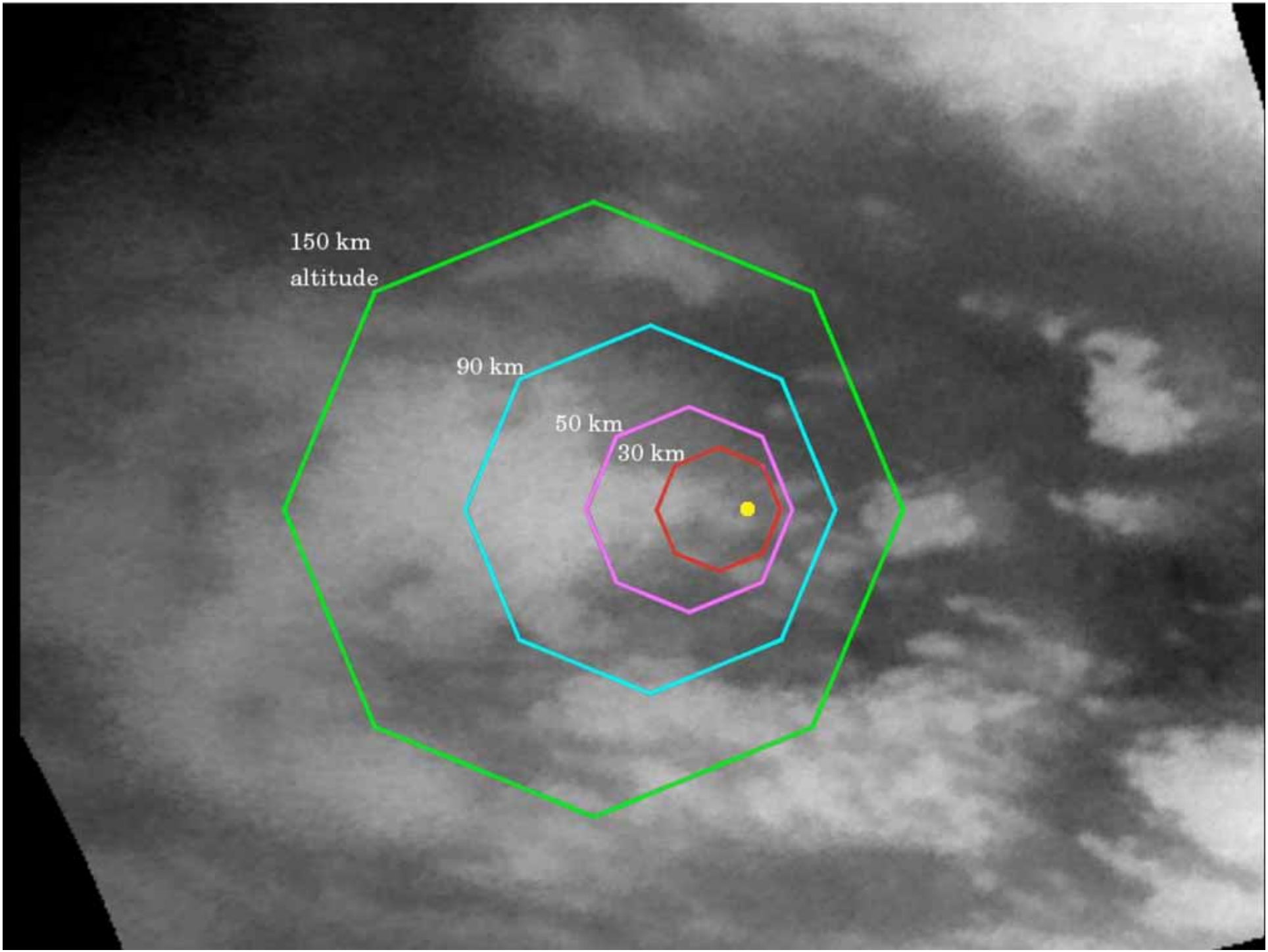

30 June / 1 July 2004

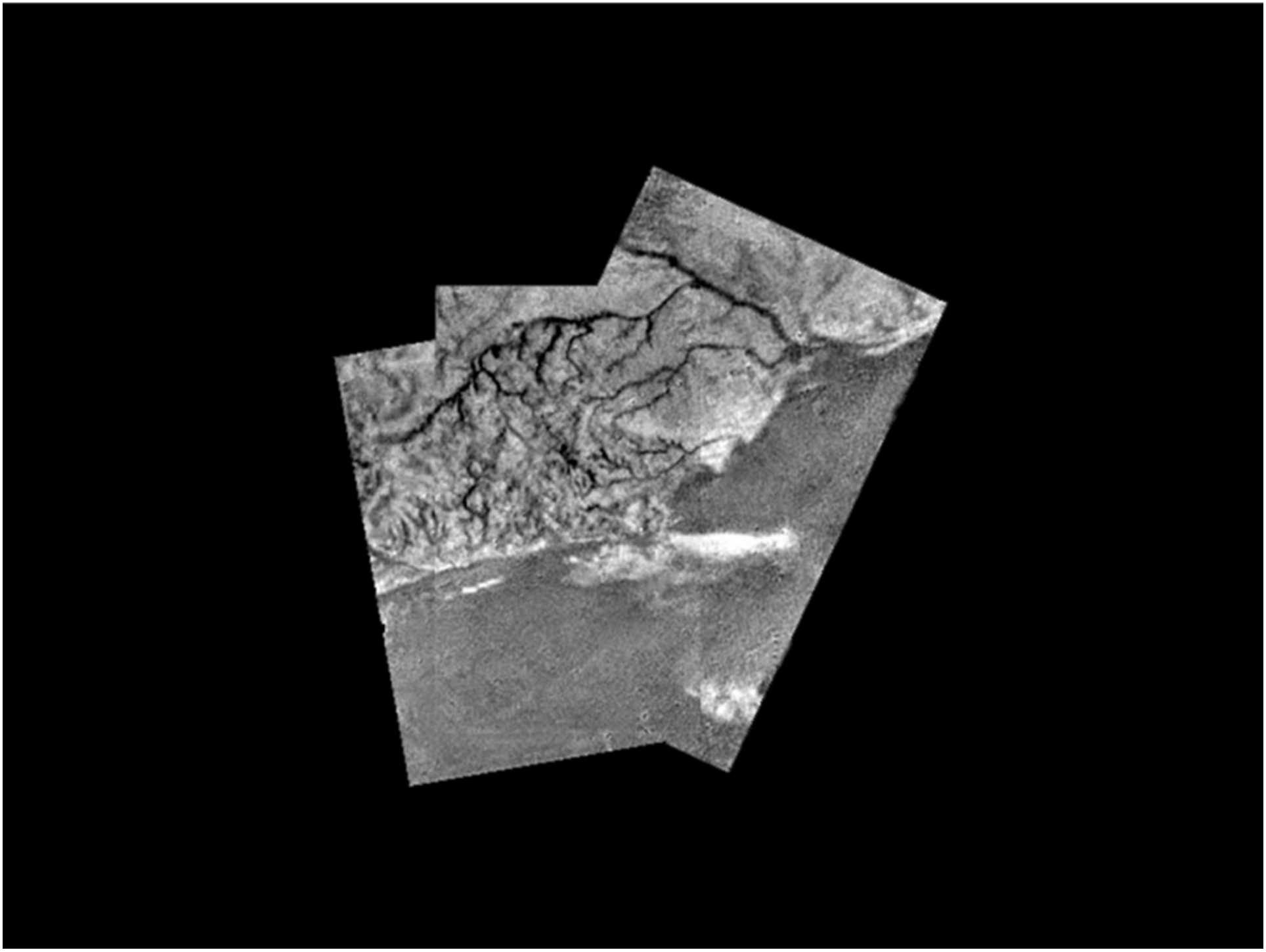


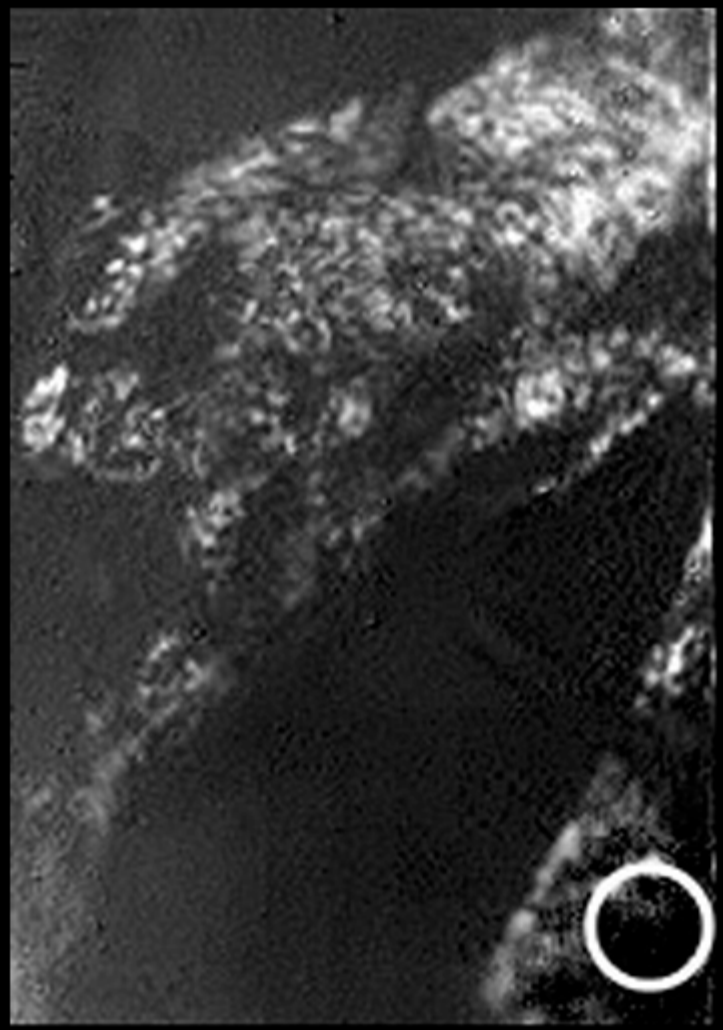







150 km
altitude
90 km
50 km
30 km





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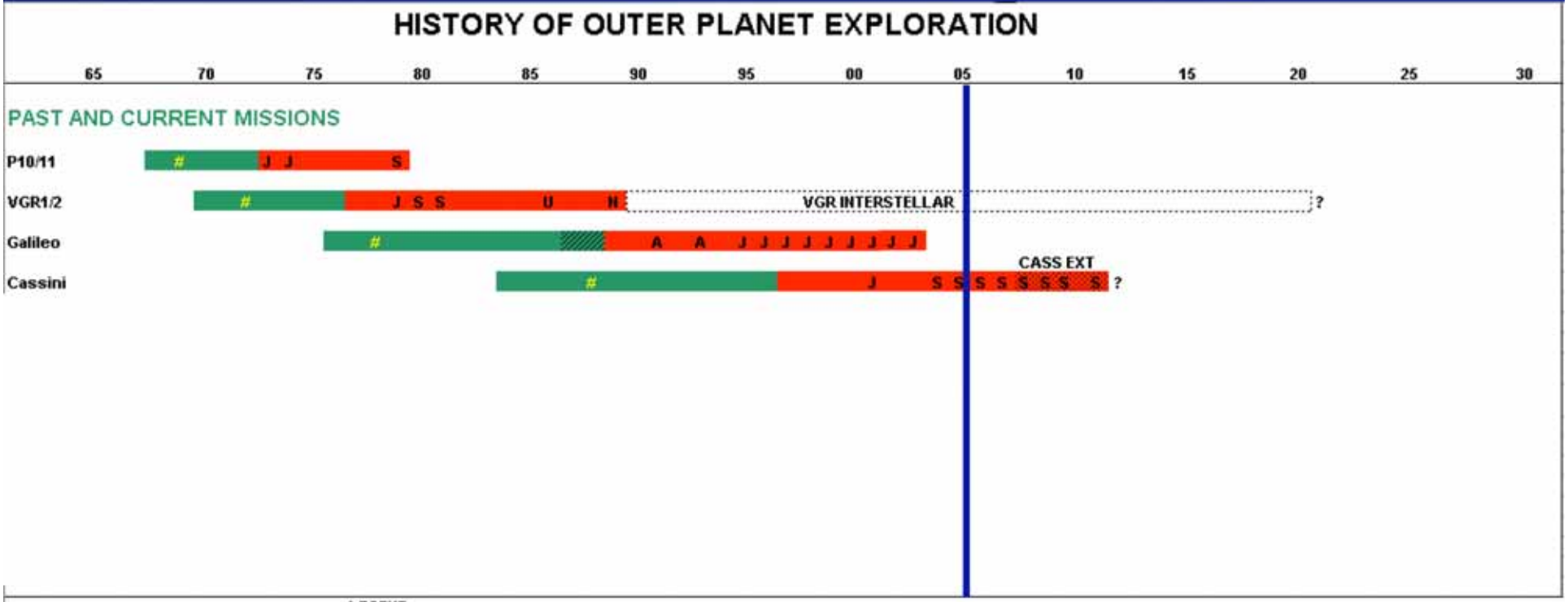

LEGEND

SCI. REC.

NEW START

TARGET(S)

X Y

PLANNING & DEVELOPMENT

OPERATIONS

T. V. Johnson, December 2004

Comments on Outer Planet Exploration

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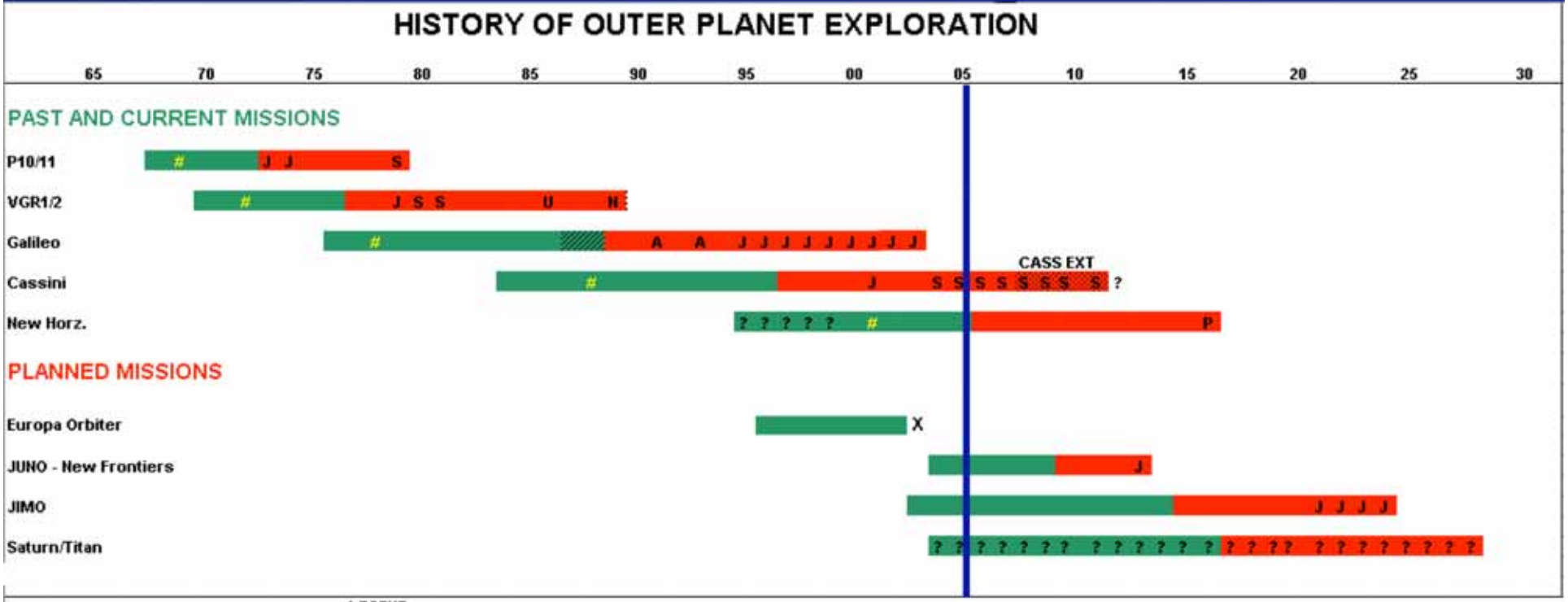

T. V. Johnson, December 2004

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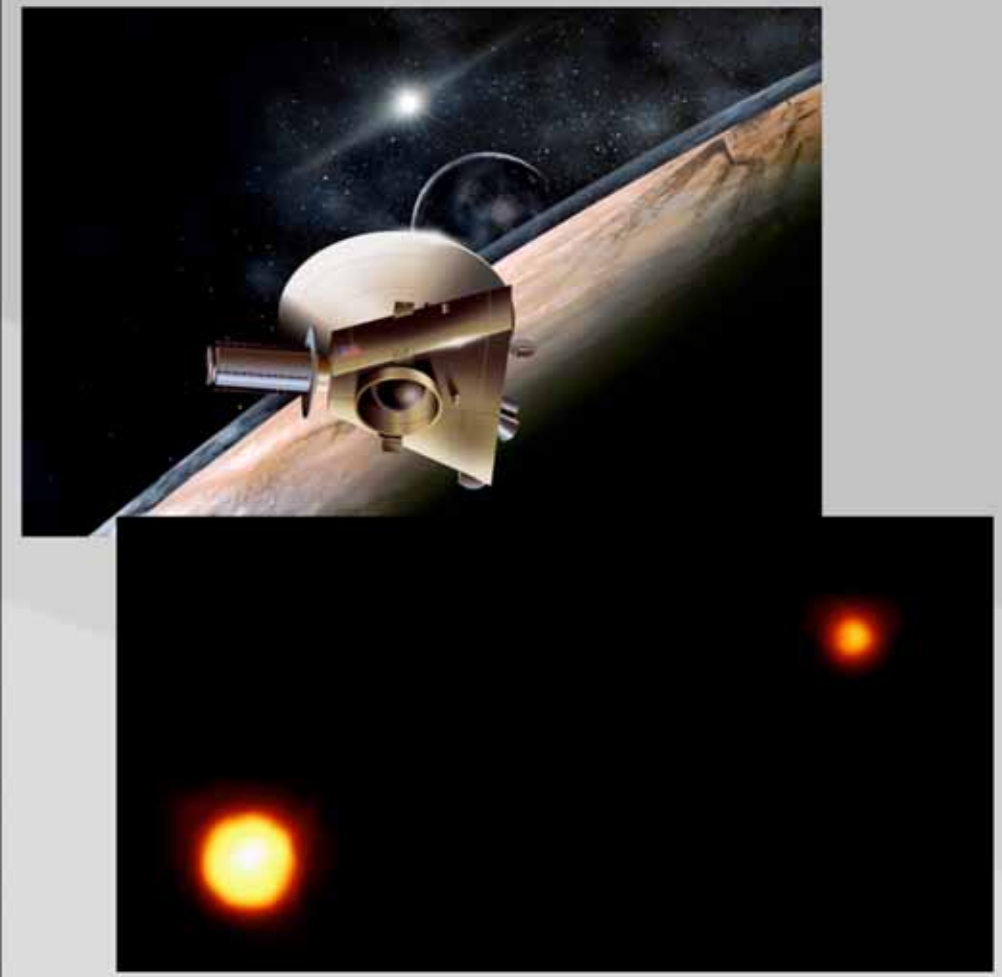
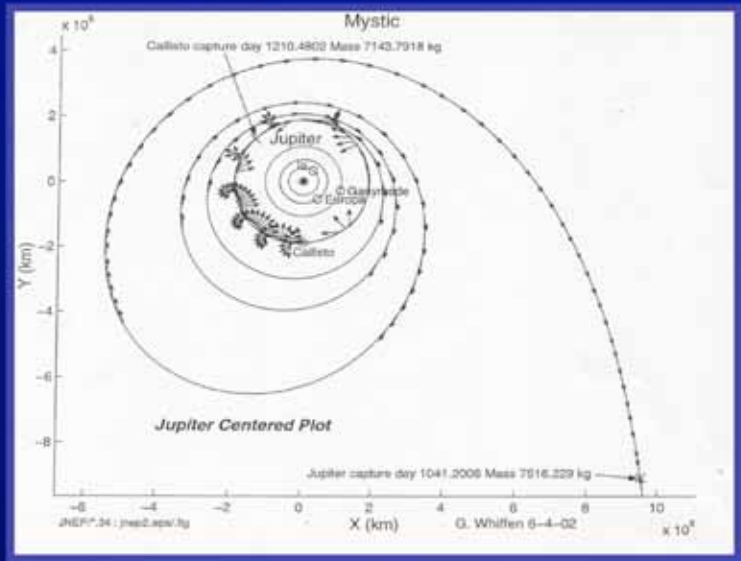
New Horizons

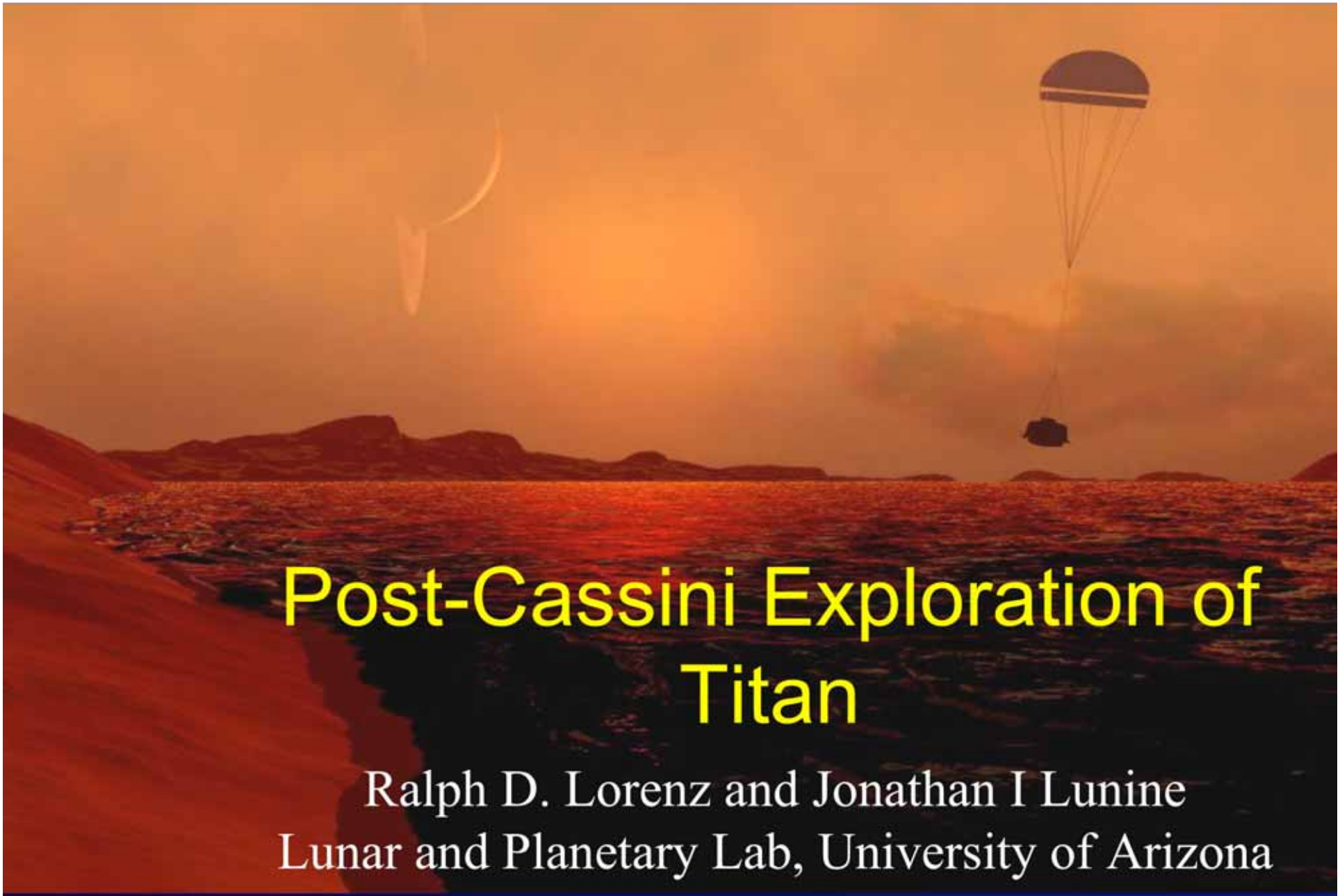


- Mission: Pluto-Charon and other Kuiper Belt objects
- First of the New Frontiers Missions
- Proposed Launch: 2006
- Scientific Goal
  - First reconnaissance of the the Pluto/Charon system and other Kuiper Belt objects
  - Study surface properties, geology, interior and atmosphere
- Principal Investigator: Dr. Alan Stern, SwRI

Jupiter Icy Moons Orbiter

Using Nuclear Electric Propulsion
to explore the water worlds of Jupiter





Post-Cassini Exploration of Titan

Ralph D. Lorenz and Jonathan I Lunine
Lunar and Planetary Lab, University of Arizona

Future mission prospects - in-situ exploration

Image by Mark Robertson-Tessi and Ralph Lorenz

Low gravity as well as thick atmosphere - favours heavier-than-air.

Rotary-wing concepts attractive for surface access.

Actuator disk theory - hover power for fixed mass, rotor is 38x less than on Earth

To be continued .....